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PUBLISHER'S REMARKS

Wayne Green

Help Your Library

Your local library subscribes to magazines that are requested by customers, so the next time you are near a library, please stop in and ask if they have *Kilobaud MICROCOMPUTING*. If they get a few requests we'll be hearing from them with a subscription.

It is even more important to be sure that the magazine is in as many school libraries as possible. What better way to help newcomers to computing to get an understanding of the field? You can help bring enjoyment to a lot of people (not to mention me) by helping to get us into as many libraries as possible.

Many schools are now exposing kids to computers, so there is a strong need for the information in *MICROCOMPUTING*. Make this information easy to get by having it in your local library. If you are a teacher, be sure to keep after the school librarian.

What to Write

Programmers call up and ask what kind of programs are needed for microcomputers. In view of the dearth of programs so far being published, this is akin to asking, "Gee, what can a computer do?" Besides business, control, home, game, educational, scientific and systems programs, honestly I can't thing of much that is needed.

Now that we have disks for the TRS-80, is someone working on a nice file-handling program? We do need a good operating system for the 80, one that might allow us to set up any files we want in a data-base manner and then access them at will. We might want to keep recipes—just to reach into the cliché barrel—or a Christmas card list, an index to interesting magazine articles, a list of credit cards or serial numbers of equipment and appliances in case of theft. The list of lists is endless.

In the home we need lists of books in our library, of music on records, of friends, of things we plan to do. We need help with our damned checkbook and with tax preparation. We may like to have a little program that will tell us how much we actually net from a salary increase, should such an event threaten.

In the office we need programs for showing sales, for projecting inventory needs, for keeping track of phone calls, for looking up names and addresses or phone numbers, for keeping a diary. Almost any small firm would rush out and buy a computer tomorrow if it would keep track of all of the phone calls made and list the number called, the amount of time talked, the extension originating the call . . . and then could check the number against an authorized list . . . all for under $2000. That's equal to about $50 a month, and most firms would save far more than that on non-business phone calls.

How about a program for a two-terminal system . . . one on the boss's desk and one with his secretary? This could provide the boss with all that telephone-number data and also act as a private communication system between them. The secretary could list calls to be made, calls waiting, appointments, things to be done and meetings. You can bet that a system like that would sell zillions of systems, including the software. Are you busy writing yet? Let's say that the program to allow a TRS-80 with two terminals and a couple of disks to do the above would sell for $200. That would mean a royalty of at least $20,000 per month, if the hardware people could keep up with the demand. Hey . . . where did you go?

Career Opportunities

The staffs at *Kilobaud MICROCOMPUTING* and Instant Software are growing every month, yet attractive career positions are still open. For instance, we need a good microcomputer technician—someone experienced in working with a number of different systems, who can keep our many microcomputers in good shape and set up new ones as they come in. We have piles of boards and all sorts of accessories and a shortage of people to do all this. This type of "work" should put a hobbyist in seventh heaven.

As our data-processing needs grow, so does our need for a data-processing manager. This job would entail seeing to it that we had the programmers needed to handle all of the data processing required for the magazines and Instant Software. We'd be using the Prime, if we could ever get it to do more than one thing at a time without bogging down . . . and as many microcomputers as we can put on line. You may be sure that we will be making much ado over any systems that can be used for work.

In addition to a good microcomputer technician to set up and test new hardware—and have it in working order to check out submitted programs—we also need an editor-in-chief for the project.

The editor would be responsible for working with programmers to help them develop needed programs for publication. He would also be in charge of checking submitted programs and running them through the associate-editor system. His responsibility would end with the acceptance of the finished and debugged program for publication.

The job would be quite similar to that of a magazine editor who had to work for the development of articles for publication.

The editor would have to make sure that there was as little duplication of programs as possible, that the best of each type was accepted . . . and that programmers are made aware of what types are needed.

A familiarity with BASIC, assembly and machine language would constitute a good background for such a job. The more programming experience, the better. What will the job pay? It will probably start at around $250 a week and go upward with the sales of Instant Software.

Obviously, this is not a job that can be handled remotely.

People are also needed in marketing, advertising and other aspects of Instant Software sales.

If any of these positions sound made to order for you, and you don't smoke, write to me and convince me that I can't do without you. I think we can make a lot of money, and I'm looking for the people who can make this happen. If you are salary oriented, work-hours oriented, title oriented, need close supervision, prefer an IBM-style office, then this will be a waste of your time and mine. If you are looking for a place to grow, where the possibilities are almost unlimited, where you will be working with a group of other career-oriented people, where the final result is what is important, then you really should write. If you are too important to empty a wastebasket, to help carry some boxes of magazines, to write your own letters, try IBM.

Write a letter in your own words and make it good. One of the first tests when you get here will be to make sure you are able to read and write English. You'll have to sit down at a typewriter and answer a couple of letters of complaint. This will tell me whether you have learned to write or not and whether you are used to a typewriter. How can a computer person or a journalist—or even an executive—get along without being able to write and type?

You already know that Peterborough is a good place to live, so I won't dwell on that. The air is

(continued on page 22)

Reader Responsibility

One of your responsibilites, as a reader of *Kilobaud MICROCOMPUTING*, is to aid and abet the increasing of circulation and advertising, both of which will bring you the same benefit: a larger and even better magazine. You can help by encouraging your friends to subscribe to *Kilobaud MICROCOMPUTING*. Remember: Subscriptions are guaranteed—money back if not delighted, so no one can lose. You can also help by tearing out one of the cards just inside the back cover and circling replies you'd like to see: catalogs, spec sheets, etc. Advertisers put a lot of trust in reader requests for information. To make it more worth your while to send in the card, a drawing will be held each month and the winner will get a lifetime subscription to *Kilobaud MICROCOMPUTING*!

This time around, the winner of a lifetime subscription is Norman Lingren of McGuire AFB.

Guest Editorial

"Review That Book!" is a guest editorial by *Kilobaud MICROCOMPUTING* Associate Editor Rod Hallen.

With the enormous number of newly published books aimed at the personal computer user coming on the market, it is almost impossible to keep up with the titles, let alone buy and read them all. How can you determine which ones are worth owning and which ones to pass up?

You can, of course, browse your local computer store book rack. But unless you are prepared to spend a great deal of time at it, you can't possibly study many books to any great depth. That's where the book reviewer comes into the picture. Let him do your book-rack perusing for you. I say him, but I really mean many hims (or hers) because no one person can do it all.

It is not so much my intention to turn you on to book reviews as a source of buying information as it is to turn you on to them as a source of knowledge and money. This commentary's designed to interest you in writing book reviews.

Why should you consider a career(?) as a book reviewer, and what is in it for you? If you have ever wanted to be a writer, here is a way for you to get started. It won't take up a lot of your spare time. Unfortunately, while it is a paying occupation, you will never get rich pursuing it. However, there are other benefits you should consider.

One of these benefits is free books. Many publishers are quite willing to provide sample copies of their latest creations to established reviewers. When I say "established," I mean a writer who is objective and one who can get his reviews printed. This means that you can't just write to a publisher and request a copy of a book that interests you until you first establish yourself. But once you have had a few reviews appear in the various computer magazines, then you can point to them as proof that you are capable.

Another benefit is the number of interesting and educational books that you get to read. I have never read a book that didn't teach me something; therefore, the more I read the more I learn. I believe that in order to be a writer you must be a reader, and I make my living writing.

I also mentioned money. Magazines pay money for book reviews. I happen to know that *Kilobaud MICROCOMPUTING* needs book reviews right now. They are also looking for reviews of various hardware and software items, but that is another story.

All right then, how do you get started? That should be easy with the information I'll cover before we're through here. The first thing most hobbyists do when they become interested in a particular subject is to buy some magazines and some books about that subject. If you have any computer-oriented books on your home bookshelf, you are halfway there. If you can borrow them from your public library, that is OK too.

What to Look for

What do you look for while reviewing a book, and how do you present what you want to say about it? First, study some of the reviews in the magazines that you read. In each case the person who wrote the review wanted to convey his impression of the contents and value of a book. Take one of the books that you have in your personal library and read it again. Start with one you were satisfied with and one you feel would be of interest and assistance to other hobbyists.

Do not pick a book that is way over your head. While you might get something out of it, it will be difficult for you to effectively evaluate it. I have an APL programming manual that I think is outstanding, but since I don't have APL running on my SOL, I don't really feel qualified to judge the manual. By the same token, if you are fairly well advanced you might find it hard to read and review a basic beginner's book because you no longer have the point of view of a novice.

As you reread the book, keep a pencil and paper by your side to jot down thoughts as they occur to you. Indicate points where you had some difficulty understanding the author's meaning and points where you feel he did an especially good job of getting his thoughts across to you.

Note anything that enhances or detracts from the material that is being presented. This could include poor reproduction of photographs, a book binding that falls apart, language that is too sophisticated for the intended audience or superior graphics. Anything that you feel weighs one way or the other should be mentioned.

If the author champions some particular point that happens to be a pet peeve of yours, don't tear the entire book apart because of it. Drop the book and try another if you can't be objective.

If it is a "read and do" type of book that requires you to perform some function such as creating programs to solve problems, answering questions, etc., then do it. Look at a book the same way a first-time reader would.

You might also suggest possible improvements. Remember that a book is only one author's and/or one publisher's opinion on a given subject. However, don't try to give the impression that you could have written a better book on the subject yourself. If you could have, why didn't you?

The Manuscript

The mechanics of writing and submitting a manuscript are relatively simple, but there is a set routine. Handwritten articles are frowned upon. Always type, double spaced, on white 8½ by 11 non-erasable paper. Minor pen and ink corrections are OK as long as they are legible. Margins of about 1½ inches left, right, top and bottom leave the editor room to make notes or changes.

The first page should include the name of the book, the author, the name and address of the publisher or distributor and the copyright date. Give a physical description of the book and the price—for instance, "softbound, 9 x 12 inches, 301 pages, $12.95." Your name, address, the title of your review and a page number should appear at the top of every page.

Some editors desire or require a count of the number of words an article contains, but I have never had one rejected because I omitted that item. Almost all editors require that an SASE (self-addressed stamped envelope) accompany each manuscript you submit. Otherwise, they are under no obligation to return it to you if they decide not to use it. Finally, a short cover letter introducing yourself and your

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Cover: DISCUS/2D by Thinker Toys, Berkeley CA. (Photo: H. Olson, P. Gorchoz)

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review would be appropriate.

Naturally, since I am a confirmed computer hobbyist, I do all of my writing and rewriting on the video screen. Then my Electric Pencil word-processing system formats and prints the final manuscript error free on my Teletype Model 43 KSR. I don't even own a conventional typewriter.

How long should a review be? As long as it takes to say what you want to say. Don't try to cover so much ground that there is no reason for your readers to buy the book, but don't be so brief that you don't really say anything.

Conclusion

As a book reviewer it is your right (and responsibility) to express your viewpoint. Also keep in mind that it is not necessary or honest to say a lot of nice things about a book just because you were given a free review copy. If it's not too good, don't be afraid to say so. Honesty is an obligation: to the author, the publisher, your readers and above all to yourself.

The final part of a book review should always include your judgement as to its value. Don't count on the comments you make during the review to completely clarify your point of view. Recap your reasons pro and con and then make a recommendation for purchase or rejection. If you want to qualify your reasoning in some way—for instance, good buy for an advanced hobbyist but too steep for the beginner—then by all means do so. Above all, this is a personal opinion, say what you think.

And just because you've seen a review on a particular book in one of the magazines, don't let that stop you. Send yours to another. After all, two opinions are better than one.

OUTPUT FROM ISI

Sherry Smythe

We checked over the new burglar-alarm system at our new offices and felt pretty smug. But before we could move all our equipment to the new micro-lab, someone entered the old lab and stole our Jupiter Wave Mate with two disks and our North Star Horizon system. The crooks were fast workers. They had to enter through two locked doors, disconnect the equipment, re-lock the lab and steal the stuff all in less than an hour.

Instant Software is offering a $1000 reward for the return of the equipment and information leading to the arrest and conviction of the culprits. (The Jupiter serial number is Q61D4 5911-5; the North Star serial number is 10-01319.)

Program Submissions

As predicted by just about everyone so far involved in publishing programs, a high percentage of the material submitted is unusable. I have some suggestions.

First, to save our time and yours—plus some expenses on your part—why not have one or two friends check out your program and make sure it seems worthwhile to them? Try to get an unbiased opinion. If they turn thumbs down, perhaps you'll be able to discuss it with them and come up with some ideas that will make the program better and win their stamp of approval. This will be worth a lot to you if it makes your program acceptable for publication.

Try to make your program as complete as possible. Furnish as much documentation as you can. Be sure to put *only one* program on a cassette and mark it with your name and address, etc. Put your name and address on the back of every sheet of paper you send.

If you come up with improved versions of your program and want to send them later, be sure the new cassette and documentation are clearly marked as revisions.

Some of the cassettes are either difficult or impossible to load in our systems. Be sure you clean your recorder heads before making the tape. Then, for heaven's sake, check the cassette out on your own system before sending it to us. Cleaning those recorder heads is extremely important, believe it or not. We're used to using an audio recorder for years without cleaning the heads and not suffering too much. With digital material we find that we must clean the recorder heads every day or so in the lab.

What kind of programs are needed? Home, scientific, business of almost any kind, math, educational. Until there is a library of several thousand published programs, it will be difficult to find computer applications where programs are not needed. One thing to remember: the first one in with a good workable program will probably be the one who makes the fortune; so those programmers who procrastinate may have little to eat other than their heart. It can be very frustrating to see some programmer raking in tens of thousands of dollars for a program that isn't nearly as good as yours . . . just because he got there a day earlier. How many hours late was Grey in trying to patent the telephone? Bell got there first. That was several billion dollars' worth of too bad.

Improvements, Problems

Our bulk packaging has been improved. All the new labels are brighter and make it much easier for the customer to determine which programs work with his computer. All the booklets have been updated to provide more information and to be easier to understand.

We had been waiting for our associate-editor program to be debugged and put into operation. Just when it was nearly completed . . . it was stolen with the North Star Horizon.

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C	A	L	E	N	D	A	R

Aggieland TX

Micro Expo '79 will be sponsored by the Texas A&M Microcomputer Club. Place and time: Texas A&M University Memorial Student Center, Friday, March 2, 1 PM to 6 PM (setup only) Saturday, March 3, 9:30 AM to 6 PM, Sunday, March 4, 9:30 AM to 3 PM. For additional information, contact: Larry Brown, Chairman Micro Expo '79, Texas A&M Microcomputer Club, PO Box M9, College Station TX 77844, (713) 693-5748.

Contest!

Back in December, we printed a ballot listing the 12 articles that had been voted "best of the month" for the preceding year. The votes have been collected and tabulated, and now it's time to announce the winner, who will receive a check for $500.

The article readers voted best was "The TRS-80: how does it stack up?" by Ed Juge.

Congratulations, Ed.

Meanwhile, the "best article of the month" contest continues. The winner for December 1978 was Barry A. Lewis, author of "Deep, Dark Secrets of the TRS-80 (Level I)."

Congratulations to you, Barry.

PET-POURRI

Len Lindsay

PET Accessories

The PET is rapidly becoming a well-supported personal computer, though *not* by Commodore. Several companies have announced that they now are offering full-size plug-in keyboards; I have not yet seen any of these.

PERK is available from George Risk Industries (GRI Plaza, Kimball NB 69145) for $229.95. It shares the PET internal keyboard interface, allowing both keyboards to be used. More than one PERK keyboard can be attached to a single PET.

The BIG-KB Keyboard from Skyles Electric Works (10301 Stonydale Dr., Cupertino CA 95014) also plugs into the PET internal keyboard interface, and both devices can operate simultaneously. For $125 you get a keyboard including a numeric keypad.

As I mentioned in the January issue, New England Electronics (248 Bridge St., Springfield MA 01103) manufactures a full-size keyboard. The announced price is $139.95. Finally, Excel (2241 Tamalpais, El Cerrito CA 94530) markets a keyboard for $175.

Software Worth Mentioning

The Software Shoppe (PO Box 271, Berwyn IL 60402) has some excellent software, using extensive machine language for speed and versatility. Having seen and used their Extended Graphics package, I rate it superb. Although it doesn't add any graphics, it allows you to use PET graphics easily, for results not possible with BASIC.

Channel 6 TV in Madison WI recently had a one-hour special presentation of computers in the home. I was a guest on the show and brought my PET and some programs (including the Extended Graphics package). It took me less than five minutes to set up and run an amazing animation of the show's logo, using Extended Graphics routines. Among many other uses, these routines allow you to animate a whole section of any rectangular size on the screen.

The Software Shoppe also has a resequence program using machine language. It renumbers your program and changes all your GOSUB, GOTO and IF-THEN target lines accordingly.

Micro Software Systems (PO Box 1442, Woodbridge VA 22193) offers a Basic Utilities Program called Micro-SET I. With this program you can delete blocks of lines, create ASCII tapes of any program, add routines from tape to the program in the PET and renumber the lines. It renumbers the lines only, but tells you which lines have GOTO, GOSUB or IF THEN and what to change the target line to.

Cursor (Box 550, Goleta CA 93017) has my highest recommendations. You subscribe to *Cursor* like any magazine, $24 for 12 issues. Each issue comes by first-class mail on a cassette ready to LOAD and RUN on your PET. Each issue contains about six good programs. I have received the first four issues and have never suffered a problem loading the programs. It contains useful and educational programs as well as unique and fun games.

Program (Box 461, Philipsburg PA 16866) also is a cassette magazine, $27 for 12 issues. By all means avoid it. I have heard complaints that their tapes wouldn't load and they would not refund any money. (One person wrote to the *PET Gazette* about this and then supposedly got a refund.)

I had the opportunity to see *Program II.* It was a complete disappointment. The first "program" was 12 lines long (could be condensed to seven lines) and did next to nothing. The second "program" was five lines long. It showed (in one line) how to have the PET pause a few seconds. The third program was six lines long and simply printed the PEEK value of address 515 when you hit a key. The last program was the longest, 17 lines, but had problems causing it to work improperly. Along with these four "programs" were a few editorial comments thanking people for sending in programs and asking for more, among other things. *Program* is put out by the same people who publish *PETABLE*, which I mentioned last month.

Last Minute Addition: I have just received a complimentary copy of *Program II* directly from *Program*. The accompanying letter asked that I not review their products "until we can get things under control." I found it odd that the tape they sent to me as *Program II* was different than the one sent to one of their subscribers. The programs on my copy were: Memory Check, ZIP File and Accounts Receivable. You may draw your own conclusions about that.

Software Survey
Topic: Fantasy Simulations

Each month I will choose a category of program types and review some of the best (and worst) programs available. Companies: Please send in your programs so that they may be included in future reviews. Users: Please send in your recommendations for good programs and warnings for poor ones. Future topics will include: Card Games, Educational, Board Games, Strategy Games, etc.

I chose the simulations category this time because I feel that simulations are one of the best recreational uses, and fantasy types are very enjoyable. There will probably be many more entries in this area soon, especially the dungeon and dragon types. Devils Dungeon by Engel Enterprises (PO Box 16612, Tampa FL 33687) is a good example to begin with. It comes as a small booklet with the background story, sample run, program listing, flowchart, list of variables used and possible modifications. If you would like it on tape ready to run, contact Jon Staebell, 5102 Arrowhead Dr., Monona WI 53716.

In this adventure you move about in a maze of caves, forever descending into the earth. Some caves contain drop-offs allowing you to move to a lower level. You *never* can move back up. There is a lot of gold scattered throughout the caves. As you try to collect as much gold as you can, various monsters attempt to stop you. You may fight the monsters, run away or use your magic wand. For each monster you kill and piece of gold you find, you are given experience points. These may be traded in to add to your speed and strength. Encounters with monsters, demons and poisonous gas all reduce your speed or strength. If either goes below zero you are declared dead. This exciting game is well worth having. Jon's version has excellent sound effects as well.

Wumpus might be considered a primitive form of a hunt simulation. Its program listing was printed in *Kilobaud* No. 2. It is available from several sources including Dr. Daley (425 Grove Ave., Berrien Springs MI 49103) and the PET Cassette Exchange (1929 Northport Dr., Room 6, Madison WI 53704). The Wumpus lives in underground caves. You enter their caves, try to find and kill a Wumpus and escape alive. Beware of pits and bats!

A step up from Wumpus is Quest, available from the Computer Project (Peninsula School, Peninsula Way, Menlo Park CA 94025). Quest is a find-the-treasure game that involves exploring caves with hidden clues and changing obstacles.

The August 1978 issue of *Kilobaud* had an article and program listing for Swords and Sorcery. This fantasy game was adapted for the PET by Biosystems Research (11550 SW 108 Ct., Miami FL 33176) as a tape with a graphic introduction and complete game ready to run. The graphic introduction is fantastic. The game is very simple to play (the program is complex). You wander through the forest, try to reach the princess and find enough gold along the way to be worthy to marry her. You meet trolls and goblins as well as fall into pits. Since it is simple, children may enjoy it. However, I felt it was boring, and I never found the princess during the several times I played it.

Swordquest by Fantasy Games Software (PO Box 1683, Madison WI 53701) is the only fantasy simulation I have seen with graphics and animation (and sound effects soon, too). The program is complex and has several machine-language routines. It is well human-engineered and easy to play, but challenging and exciting at the same time. You wander about a maze of tunnels, trying to find the room with the treasure. You can kill any monsters with your arrows (except for giant spiders; you need a magic arrow to assure a kill). The maze of tunnels is always shown on your screen; there is no scrolling. All monsters are invisible until you come within four steps of them. They then appear and charge at you, moving three spaces each turn. You can do two things for your turn, including move, shoot an arrow and change weapons. You must decide to carry either your bow or your sword. You must use your sword

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```
75 ?"Do you understand?

77 ?"If you say Yes everything you have just read will be erased

80 POKE 525,0:WAIT 525,1:GET Q$:IF Q$<>Y THEN RUN : REM read again

89 REM erase lines up to 99 follows

90 POKE 59409,52 : F=1 : L=99

92 B=92:?"[CLR,DOWN,DOWN]":FORI=FTOF+8:IFI>LTHENB=100

:NEXT:?"POKE59409,60:GOTO60040

93 ?I:NEXTI:?"F="F+9":L="L":GOTO"B

94 POKE 525,10:FORN=0TO9:POKE 527+N,13:NEXTN:?"[HOME]":END

100 REM your program starts here.
```

Example 1. (Lines 75, 77, 80 are merely lead-ins.)

```
100 PRINT"First let's erase lines up to 100 to"
110 PRINT"make room for running the game."
120 REM   CURSOR UP PRINTS AS A "1", SO
130 REM   PART OF THE NEXT LINE SHOULD
140 REM   BE KEYED AS:
150 REM   160 PRINT"HIT A KEY [UP]"....
160 PRINT"HIT A KEY ":GET A$:IF A$="" GOTO160
170 REM**DYNAMIC KEYBOARD**
180 REM   NEXT INSERT THE FIRST AND
190 REM   LAST LINES TO BE ERASED
200 FIRST LINE=1:LAST LINE=22
210 REM***********************************
220 REM   THE NEXT LINE NUMBER SHOULD
230 REM   BE THE FIRST LINE OF THIS
240 REM   SUBROUTINE - USUALLY IT'S
250 REM   OWN LINE NUMBER
260 BEGIN=260
270 REM***********************************
280 REM   THE POKE VALUE OF RETURN
290 REM   IS 13
300 CARRIAGE RETRN=13
310 REM***********************************
320 REM   KEY NEXT LINE AS:
330 REM   350 PRINT"[CLR,DOWN,DOWN]"
340 REM   READY TO PRINT LINE NUMBERS
350 PRINT" "
360 REM***********************************
370 REM   I IS THE LINE NUMBERS TO
380 REM   BE ERASED
390 FOR I=FIRST LINE TO FIRST LINE+8
400 REM***********************************
410 REM   IT STOPS ERASING AFTER I IS
420 REM   GREATER THAN YOUR CHECK LINE
430 REM   SET BEGIN TO THE NEXT LINE OF
440 REM   YOUR PROGRAM TO BE EXECUTED
450 IF I>LAST LINE THEN BEGIN=1000
460 REM**********************************
470 REM   NEXT PRINT THE LINE NUMBER
480 PRINT I
490 REM**********************************
500 NEXT I
510 REM**********************************
520 REM   DELETED, ALL VARIABLES ARE
530 REM   SET TO 0 - NEXT WE PRINT THE
540 REM   INFO NEEDED TO CONTINUE THIS
550 REM   SUBROUTINE
560 PRINT"FIRST LINE=" FIRST+9;
570 PRINT":LAST LINE=" LAST ":GOTO" BEGIN
580 REM**********************************
590 REM   NEXT THE KEYBOARD BUFFER IS
600 REM   FILLED WITH RETURNS
610 REM   THESE RETURN THE BLANK
620 REM   LINES NUMBERS WE JUST PRINTED
630 POKE525,10:FOR N=0 TO 9
640 POKE527+N,CARRIAGE RETRN
650 NEXT N:REM**************************
660 REM   KEY LINE 730 AS:
670 REM   730 PRINT"[HOME]":END
680 REM   THIS PUTS THE CURSOR TO THE
690 REM   HOME POSITION AND ENDS THE
700 REM   PROGRAM. THUS PET NOW LOOKS
710 REM   AT IT'S KEYBOARD BUFFER TO
720 REM   SEE WHAT KEYS HAVE BEEN HIT
730 PRINT"":END
740 REM*********************************
750 REM   THE LINE ERASING ROUTINE
760 REM   IS OVER NOW
1000 PROGRAM CONTINUES HERE
READY.
```

Program A. Automatic line-erasing routine.

to fight any monster that attacks you. The intricacies of this game are explained in the accompanying manual. The manual also relates the background story to the game.

In addition, Fantasy Games Software has several other excellent games that are almost ready for distribution.

Last is Hunt by Mike Richter. It has been renamed since last month when I mentioned it as Hypergame 1. It is a game that really is a class in itself, a metagame (in the sense of metaphysics). The context is a search for a defined object. The object, the names and natures of the searchers, the names and effects of the antagonists and the properties of the space in which the hunt is conducted (up to 16 regions) are all variables defined by a data tape.

Huntwriter, the second interactive program in this set, helps define and create data tapes to be used with Hunt, which changes with each new data tape. With the aid of Huntwriter, you can change or construct new worlds for Hunt. And no knowledge of any computer language or adherence to the formalisms of programming is required (although it does demand clear thought).

Firstworld, Filmworld of Oz and Haunted House are three of the data tapes available now for Hunt and Huntwriter. Thus with less than 8K of RAM you can travel with Frodo through Middle Earth or trace adventures of King Arthur's court. And the user can set up this world without having to write a program.

Hunt is more than a fantastic interactive adventure. It is one way to involve non-programmers in software. It also is educational, both in the playing (map drawing, organization) and in the creating. The parent and child can create their own world, or a freshman history project can recreate an era in history.

If you are interested in Hunt, Huntwriter and any sample data tapes for them, please contact the *PET Gazette*, 1929 Northport Dr., Room 6, Madison WI 53704.

Sidelines

You may not have almost 400 cassettes of PET programs to store, as I do, but most PET users should have an organized and efficient method of storing programs on cassettes. I recommend using C-10 cassettes (5 minutes each side). Since rewind time is minimal, you can keep one program on each side for almost immediate access. I only have one program per tape, with the original version on side A and my improved/modified version on side B. I use only highest quality Agfa tape in a well-made cassette housing.

Acceptable C-10 tapes are available from Dr. Daley (425 Grove Ave., Berrien Springs MI 49103) for $1.25 each or 84 cents each for 100 or more. The *best* tapes I have seen and used are from a store in Madison WI, Full Compass (55 N Dickinson, Washington Square Complex). Their tapes are the best and cost only 47 cents each for 100 or more.

Always rewind your tapes after each use before storing. For $2.59, Radio Shack sells well-designed cassette folders that look like a book and hold 12 cassettes. I use over 60 of these folders for my programs. If you have printed listings or instructions you would like to keep with your tapes, you will be interested in a three-ring binder with cassette folder built into its inside front and back. They are available from 20th Century Plastics (3628 Crenshaw Blvd., Los Angeles CA 90016) for $7.50 each or $5.50 each for 6. You also can get clear plastic protectors for your listings or documentation. They hold typing-paper-size sheets and have three-ring binder holes on the side. They cost 20 cents each for *100* or more from 20th Century Plastics. You may also want full-size cassette labels so you can neatly type your program names. Ray Jacobs Audio (1419 Santa Fe Ave., Long Beach CA 90813) sells rolls of 1000 cassette labels for $15.

Programming Hints

As promised last month, I will explain how you can alter a BASIC program while it is running. PET has a special buffer (memory) for the keyboard. Last month we touched on this with the short routine:

```
POKE 525,0 : WAIT 525,1 : GET A$
```

Location 525 tells the PET how many keys have been hit since it last looked. By POKEing a 0 there, PET thinks that no keys were hit. WAIT tells it to wait until a certain condition is met, and then to continue. Try this short example:

```
10   POKE 525,0 : WAIT 525,3 : INPUT A$
```

The PET won't do anything until three keys are hit, but it remembers what those keys were.

The keyboard buffer is from locations 527 to 536. By POKEing the correct values into this buffer and setting the counter at loca-

Reader Service—see page 179

tions 525 to the correct number of characters, we can trick the PET into thinking that keys were actually hit. The POKE value of a carriage return is 13.

Now for an application that you can use in most of your programs. Many game programs use arrays or many variables. Memory has to be saved for this so that when the program is run it will not run out of memory. You can use the DIM command to reserve memory for use while running the program. Why not use this same memory for your introduction and instructions? We now will see how to do just that without using one extra byte of memory while your program is running.

There are two program listings: one annotated with REMarks; the other is as you would type it in. If you begin your program at line 100 of the short uncommented version, it is ready for your use just as it is. Add your introduction and instructions using PRINT statements on lines 1 to 89 prior to beginning your program at line 100 (see Example 1).

To modify this to erase any specific block of lines, set F = first line to be erased and L = last line (line 90), and IF I>L THEN B = starting line after lines are erased (line 92). POKE 59409,52 in line 90 turns off your video. Leave this out while you test the program. POKE 59409,60, turns the video back on (line 92).

Now you can add an introduction to all your programs. Simply fill up all available memory, saving only a few bytes for variables used in this routine and your introduction. Yes—this routine erases itself too! (See Program A.)

Ideas for this routine originally came from Mike Louder and Mike Richter. This concept has many more applications. Please write if you use this concept in another way.

Next month I will explain how the PET stores a BASIC program and how to protect as many lines of your program as you wish from being listed. You can write a program that works but can't be listed. It's easy using the method I will explain next month.

Your letters are always welcome. Send to: Len Lindsay, 1929 Northport Dr., Room 6, Madison WI 53704. Please address letters to this address, *not Kilobaud MICROCOMPUTING.*

BOOKS

The BASIC Handbook
David A. Lien
Compusoft Publishing
San Diego CA 92119
Softcover, 360 pp., $14.95

Who among us computer hobbyists hasn't felt totally frustrated when that "neat" program we copied from a magazine article failed to run in our own computers? The program was written in BASIC, wasn't it? Our computer's language is BASIC, isn't it? So why won't the program run?

We'll assume that we entered the program correctly. It probably failed to work as predicted by the magazine article writer because his computer and ours speak different BASIC dialects. Remember that over the years, more than 100 such BASIC dialects—or variations—have been developed.

The BASIC Handbook was written by Dr. David A. Lien (author of Radio Shack's popular BASIC primer, "TRS-80 User's Manual For Level I") to help you translate BASIC programs from one dialect to another. For example, if you wanted to translate a *BASIC* program written for Radio Shack's TRS-80 computer to run on Commodore's PET machine, the *Handbook* would help you do it.

Subtitled "An Encyclopedia of the BASIC Computer Language," this book provides the key that can open your computer to programs written in BASIC dialects supplied with more than 50 of the world's most popular computers. Covered are language variations used by Radio Shack, Commodore, Altair, Imsai, Apple, SWTP, Heathkit, Ohio Scientific, Control Data, Digital Group, North Star, DEC, IBM, etc.

Two hundred seventeen commands, statements and functions are described in detail. In addition, the uses of 34 operators (symbols such as the comma, colon and plus sign) are covered. These explanations are intended to supplement, not replace, those contained in your computer manufacturer's instruction manual.

Each BASIC word is described in a uniform manner. The word itself appears at the top right-hand edge of the page in bold letters centered on the picture of a video monitor. Since all words are listed alphabetically, you can quickly locate the particular word you are seeking by riffling the edges of the book's pages. "ANSI" appears to the right of the word if it has been recognized as being a part of the minimum BASIC vocabulary by the National Bureau of Standards' American National Standards Institute. A notation appearing beneath the word identifies its purpose (command, statement, function or operator).

After the word is described and its use explained, a test program (sometimes several) consisting of from four to 12 lines is given. By entering the test program into your computer and comparing your results with the sample run provided, you will be able to determine precisely how your machine's BASIC interpreter responds to that word.

A particularly useful section that appears under many BASIC words is entitled: "If Your Computer Doesn't Have It." As that title implies, it is sometimes possible to achieve a desired programming result by using a combination of BASIC terms.

For example, under the MAT PRINT statement explanation, the author describes how you can assign values to each element of an array even if your computer doesn't recognize "MAT PRINT." His recommendation: use FOR-NEXT loops in combination with PRINT statements.

A paragraph beneath each word identifies (sometimes by computer manufacturer's name) "Variations In Usage" of the word. For example, under the SPACE function, used to insert a specified number of blanks, you are told that some BASIC interpreters require you to place a "$" after SPACE.

Author Lien and Editor Dave Gunzel admit to one important omission. BASIC words used to control peripheral devices such as tape machines, disk drives and printers have not been included in this, the first issue of the encyclopedia. They claim that at this time so little uniformity exists in the use of such words that their inclusion would be premature.

Both author and editor expect to enlarge the list of BASIC words covered in future printings of their encyclopedia. "BASIC keeps expanding. We can only chase it," they lament, "but never catch it all."

In my opinion, they have "caught" enough of it to make *The BASIC Handbook* an invaluable addition to every computer enthusiast's library.

Sherman P. Wantz
Sebring FL

The Incredible Secret Money Machine
Don Lancaster
Howard W. Sams & Co., Inc.
Indianapolis In, 1978

This is the first "nontechnical" book by Don Lancaster that I've ever seen, and it fully lives up to his previous reputation. If you want to make money from something that you like to do, run out and buy *The Incredible Secret Money Machine* now. You won't regret it. Like his other work, this book comprises solid information at a reasonable price ($5.95 list). That may seem like a lot of money for 159 pages, but remember—there's no nonsense in Don's stuff.

Each chapter in *Money Machine* is dedicated to a particular phase of establishing your own "money machine" and keeping it functioning. Don has covered not just what you should do (along with examples that are taken from his own experience, or so it seems) but also what you should avoid like the plague. He tells you the whys, too. Some of this advice seems to run counter to what the local chamber of commerce or business school might want you to believe, but my own experience says that he's right every time.

If you want to get into business for yourself, this book is an absolute must. You'll learn some basic strategy and tactics and then how to get things rolling in the first three chapters. Chapters 4, 5 and 6 go into the nitty-gritty of finding the information you

(continued on page 140)

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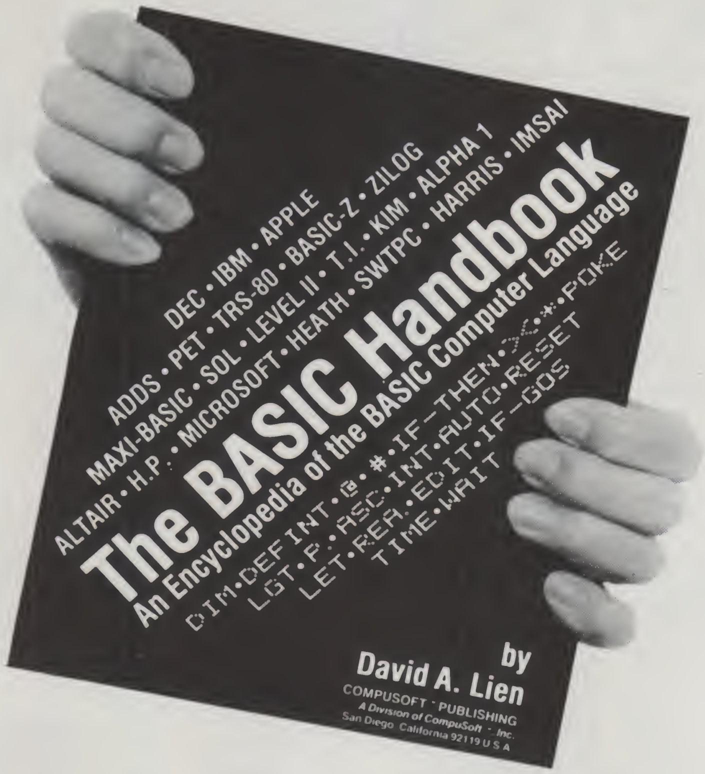

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(360 pages - Soft Cover)

From the author of the highly acclaimed TRS-80 Learner's Manual comes the book you've been asking for! THE BASIC HANDBOOK is THE definitive reference and "idea" book which explains in detail the BASIC language as used in over 50 micros, minis and mainframes.

Not a dictionary, not a text, it is a virtual ENCYCLOPEDIA of the BASIC language. Explaining all you need to know about over 250 BASIC statements, functions, operators and commands, it is the "missing link" needed to convert programs from one computer to RUN on another.

YES, I need the BASIC Handbook!

COMPUSOFT PUBLISHING 8862 Dent Drive San Diego, CA 92119

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Please send ____________ copies of The BASIC Handbook. My check for $14.95 each + $1.35 P&H is enclosed. (CA Addresses add 6% tax)

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NEW PRODUCTS

Edited by Dennis Brisson

The Sol System III package.

Gimix Microcomputer

The System 68 Microcomputer from Gimix Inc., 1337 W. 37th Place, Chicago IL 60609, features: a ferro-resonant constant voltage power supply, an *SS-50* motherboard (fifteen 50-pin and eight 30-pin gold-plated slots) and a 6800 CPU board that holds four 2708s and three independent, programmable software timers. The board also features the unique Gimix 16K software readdressable static RAM boards organized into four separately controllable 4K blocks, which allow the user to have as much memory as can be contained in the mainframe. DIP-switch features allow use of existing SWTP- and MSI-compatible software.

The system is video-based using the Gimix video board and GMXBUG 3K ROM monitor that contains the standard utility functions plus routines that facilitate software development.

8080 Text Formatting System

A full-featured text processor is now available to use with your North Star System. TFS (text formatting system) works with virtually any system configuration and any terminal (you must have RAM from 0 to 2000H).

Features of the text formatting system include: left- and right-margin justification, page output (you determine page length), automatic paragraph indentation and reverse indentation, title page and chapter headings (on user command), auto list numbering, multi-copy capability, macro capabilities (you can define a macro format and then simply "Call" it when needed), auto page number and back space command.

TFS supports a host of commands to alter text, both by string searches and substitution or by editing any specific line. The input line editor takes the worry out of typing errors. TFS also supports file mergers and appending two files together to yield one larger file. This is especially useful for form letters and other standard setups.

TFS is written in 8080 machine code and is completely "Load and Go" with the exception of the two-byte jump patch to the user's printer drivers. The cost of the system, which comes with a complete user's manual, is $75.

Supersoft, PO Box 1628, Champaign IL 61820.

TRS-80 Serial I/O Board

The TRS-80 Serial I/O Board is RS-232 compatible and can be used with or without the expansion bus. It features on-board switch-selectable baud rates of 110, 150, 300, 600, 1200 and 2400, parity odd or even or no parity, five to eight data bits and one or two stop bits. It also includes a DTR line. The board costs $19.95, $59.95 with parts and $79.95 assembled.

Electronic Systems, PO Box 21638, San Jose CA 95151.

Electronic Typing for Sol

Processor Technology Corporation, 7100 Johnson Drive, Pleasanton CA 94566, has put together a high-performance system that combines the capability of electronic typing with general-purpose data processing. The system is capable of other tasks such as general ledger, accounts payable and receivable, payroll and office functions at costs substantially lower than conventional word-processing systems. The computer system consists of a Processor Technology Sol System III-A, the new Word Wizard software package developed by Basic Computer Group Ltd. of Vancouver, B.C., and the new Sol Printer.

Hardware for the system consists of the Sol computer mainframe with built-in keyboard, a 750,000 Helios II Disk Memory, a video monitor and a high-speed bidirectional daisy wheel printer. Cost of the system is under $10,000.

Digital Integrated Circuit Tester

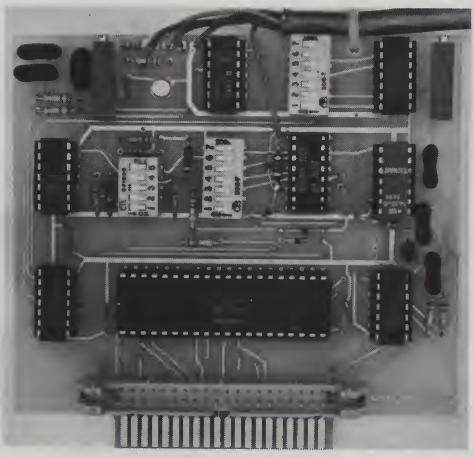
ICTM-1 allows any microcomputer to be used as a digital integrated circuit tester that performs both functional and dc parametric tests on TTL, low-power Schottky, Schottky, CMOS and NMOS devices. It can also be used to test small circuit boards and subsystems with up to 22 I/O lines.

This peripheral module can measure device fan out, fan in, supply current and other parameters. Active loads on output pins ensure that devices with normal, open collector and three-state output configurations can all be tested without any external components. Tests can be performed with power supply levels from 4.5 V to 5.5 V, allowing for worst-case testing.

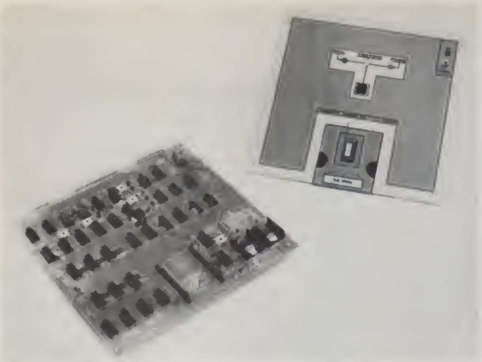
ICTM-1 interfaces to the host computer through one input port and two output ports. Plug-in personality modules with zero insertion force sockets automatically configure the tester for 14, 16, 18, 20, 22 and 24 pin devices, with a user wirable module also available. An optional interface card and cable is also offered for S-100 bus computers.

Included with ICTM-1 are the software drivers necessary to use tester functions in device test plans. These drivers are provided in 8080/8085/Z-80, 6502 and

System 68.



Electronic System's I/O Board.



The ICTM-1.

Softape programs.

M6800 assembly language. Also available for 8080/8085/Z-80 users is TBASIC (Tester Extended BASIC), a high-level control language.

The ICTM-1 costs $349.95 kit, $499.95 assembled and tested. Each ICTM-1 includes one personality module of the user's choice; additional personality modules are priced from $19.95 each. The S-100 interface module, IF-1, is priced at $89.95 kit, $119.95 assembled and tested. The TBASIC interpreter is priced at $49.95. A complete set of assembly, user and software manuals is available for $15 (refundable with order).

Pragmatic Designs, Inc., 711 Stierlin Road, Mt. View CA 94043.

CP/M-Compatible ASI Software

Administrative Systems, Inc. (ASI), announces its single-user system software, OPUS/ONE, OPUS/TWO, SOS and FORTE, on CP/M-compatible diskettes. This new format will allow users with a 32K (minimum) CP/M-based system to load and immediately execute ASI's system software packages.

Each package is structured as a *CP/M-compatible* file, which, when loaded, will execute, using the device drivers already existing under CP/M. Other files include a System Generation routine, which will allow the user to create an ASI standard system diskette with customized device drivers, and a FORMAT routine, used to set up data diskettes.

The new packages include user's manuals, which may also be purchased separately, and their cost may be credited toward the cost of the appropriate software. The software is supplied on soft-sectored IBM-3740 (eight-inch) compatible diskettes, single density.

Administrative Systems, Inc., 1642 South Parker Road, Suite 300, Denver CO 80231.

TRS-80, Poly and PET Software

A large selection of original, low-cost software is now available for the TRS-80, Poly and PET microcomputers. The following package of graphic games is just a sample of what is offered—WWIII Bomber, Lunar Lander 5 and Biorhythm. Requiring only 4K of memory, these programs on cassette cost $9.96. A free, complete catalog (please specify computer type) is available upon request.

Software Industries, 902 Pinecrest, Richardson TX 75080.

8080 Assembler

Midwest Micro-Tek, Inc., PO Box 29411, Brooklyn Center MN 55429, announces a new assembler, SASSY, to replace and upgrade the assembler in CP/M operating systems. SASSY is completely compatible with Digital Research's CP/M format and includes new features such as: cross referenced table of symbols/labels; linking up to nine source files simultaneously for program assembly; page length/width control and list/no list option. Also included are standard Intel mnemonics and pseudo-codes, symbol table generation, automatic page numbering, top-of-form control, title block and user control of error and hex destination.

SASSY is available on hard-sectored minifloppy disk or soft-sectored full-sized single- or dual-density disks in CP/M format. SASSY runs on 16K systems and is compatible with CP/M multi-drive environment. Price (with manual) is $75.

Apple II Software

Outfit your Apple II Computer with a varied selection of cassette tapes from Softape, 10756 Vanowen, North Hollywood CA 91605. The selection includes:

Bomber!—a HIRES graphics game with fast, detailed animation ($9.95).

Electronic Index-Card File—uses the Apple Disk for storing (in alphabetical order) and retrieving information such as telephone numbers, recipes, etc. ($19.95).

Appletalker—with 16K of memory or more, you can give your Apple II the power of speech ($15.95).

Music Kaleidoscope—uses input (such as from your stereo) to create a color light show ($9.95).

The Talking Calculator—transforms the Apple II into a talking 10-digit calculator ($12.95).

Apple-Lis'ner—make your own programs with voice recognition ($19.95).

Micropolis Floppy Disk Software

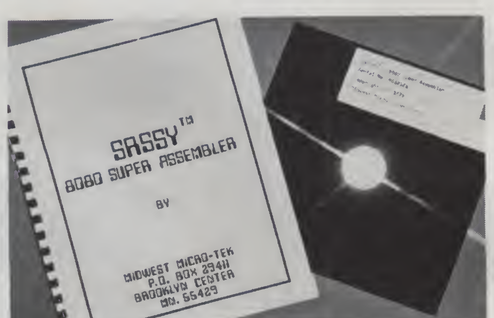
Applications software for the Micropolis Mod II floppy disk system is now available from Structured Systems Group, 5208 Claremont Avenue, Oakland CA 94618. SSG's software line, available on 8 inch disks, includes the following business applications: General Ledger, Accounts Receivable and Accounts Payable, as well as NAD, a name-and-address file that produces mailing lists according to user-defined parameters, QSORT, a full-disk sort/merge program for organizing computer files, and CBASIC-2, the latest version of CBASIC, an advanced, business-oriented BASIC language specifically designed for the CP/M operating system.

The software runs on any 8080-based or Z-80-based microcomputer with a minimum 48K RAM memory and dual disks operating under CP/M. The Micropolis Mod II system is a quad-density unit, obtaining 630K bytes of storage on two 5¼ inch mini-diskettes.

Home Poison Control and World Simulation

Two significant software products for the home computer have recently been released by Berkeley Medical Data Associates, Inc., PO Box 5279, Berkeley CA 94705.

Home Poison Control is a disk-based, medical application



MMT's SASSY.

SSG's applications software.

The CIT-PME-16.

package by Roger O. Littge, M.D., which provides emergency advice in the event of accidental poisoning in the home. Written in BASIC, the program uses word recognition to identify the names of household products or substances, then provides instructions for essential emergency treatment. The package comes complete with two disk utilities to enable expansion of the recognizable vocabulary to 2400 names (single density, single-sided North Star diskette). Maximum search time is 6 seconds. Annual updates of the vocabulary will be provided free of charge.

World Simulation is a population and ecologic computer simulation. The two versions included on the diskette are completely interactive and are suitable for sixth grade through college studies in ecology, economics, system dynamics or international policy. Based on the user's suggested changes in birth rate, food production, etc., the model projects the trends of 15 system variables—population, natural resources, pollution ratio, quality of life, capital investment, pollution generated, food ratio, life expectancy, birth rate, crowding ratio, material standard of living, natural resource usage, capital investment ratio, capital investment ratio in agriculture and capital investment agricultural fraction—from the year 1900 to the selected endpoint and prints any of three different graphs or a tabular listing of all variables.

Home Poison Control is available on North Star diskette with manual and complete source listings for $28 (manual only with source listings costs $8) or on CBASIC version 8 inch diskette with manual for $32. The World Simulation program package is provided in either North Star BASIC on 5¼ inch diskette, $28 (manual only with North Star listings costs $8), or CBASIC on 8 inch diskette, $32. Both versions require 16K of memory and are supplied with complete source files.

16-Bit PASCAL Computer

The CIT-PME-16 PASCAL Microengine is the world's first 16-bit PASCAL computer system that directly executes PASCAL object programs. The system comes complete with desktop CPU, 64K of RAM memory, dual 8-inch floppy disk subsystem, 60 cps line printer, CRT with upper and lowercase letters and the PASCAL Operating System on diskette. Also included are complete documentation and technical manuals. The UCSD (University of California, San Diego) version of PASCAL software package includes the BASIC and PASCAL compiler, file manager, editor and debugging aid.

If you don't want to order the complete system, you can purchase the PASCAL Microengine as a complete computer without peripherals. The computer costs $2995; the complete system is $8000.

Computer Interface Technology, 2080 South Grand, Grand Centre, Santa Ana CA 92705.

Transparent Memory Video Display Board

The ALTR-2480, a new 24 line × 80 character alphanumeric video interface card for the S-100 bus, features a new concept, called transparent memory, that solves the classic memory-contention problem common to all CRT displays. The CPU can access the refresh memory at any time, the display is completely glitch free, and the CPU is never interrupted. The method is completely general and does not rely on the peculiar timing characteristics of a particular CPU, so it can be used with most micro and minicomputers.

All cards, incorporated into three industry standard buses besides the S-100 bus including the Intel/National SBC-80, DEC LSI-11/2 and Motorola Exorcisor, feature memory-mapped addressing, which allows the full power of the processor's instruction set to be used for display data manipulation. The 128 location character generator features the full ASCII set including upper and lowercase characters as well as limited graphics. A 5×7 dot matrix in a 6×10 dot cell is used, resulting in a non-interlaced, completely flicker-free display. All models operate from a single +5 V power supply. A compatible family of graphics controller cards with variable resolutions ranging from 256×256 to 512×256 points is also available. Price is $295.

Matrox Electronics Systems, 2795 Bates Rd., Montreal, Quebec, H3S 1B5, Canada.

DEC Terminals

The DECwriter IV from Digital Equipment Corporation (DEC) is the company's first table-top hard-copy unit. With the look, weight and feel of an office typewriter, the DECwriter IV 30 cps terminal employs special-purpose microcircuitry to permit the user to determine such requirements as the number of characters per inch for each line, margin and tabular settings and vertical spacing between lines.

DECwriter IV comes in two models: the LA34, which accepts either roll paper or individual sheets, and the LA38, which uses conventional, tractor-fed printout paper. DECwriter IV models include a choice of four character spacings and can output 132 columns of type across an 8½ inch wide piece of paper at the most compressed setting.

DEC's high-speed terminal is the new DECwriter III, which prints copy bidirectionally at 180 cps, has a choice of eight character spacings, employs a 1K character input buffer and has microprocessor-controlled logic to permit more than 45 settings by keyboard selection.

Digital Equipment Corporation, 129 Parker St., PK 3-1/A41, Maynard MA 01754.

THE SYSTEM

SYSTEM 1 features a custom console, keyboard, S-100 bus motherboard, 16 Amp power supply, fan, 64×16 upper and lowercase video/graphics board and the MD-690A CPU board. Besides combining the 6800 processor (6802) with the S-100 bus, the MD-690A includes a 2400 baud cassette interface and interrupt-driven keyboard input. This CPU permits such options as 8K BASIC in on-card PROM, multitasking and time-sharing. There is even 2400 real-time clock circuitry provided. The MD-

DECwriter IVs (background) and a DECwriter III (foreground).

THE SYSTEM from MicroDaSys.

Housing for the AIM-65.

690A is upwards compatible with the third generation Motorola 6809 processor chip. The 6809 offers 16-bit internal arithmetic, hardware multiplication, 18 addressing modes and three times the throughput of a 4 MHz Z-80. SYSTEM 1 costs $549 (kit) or $699 (assembled).

The SYSTEM 2 starts where the SYSTEM 1 leaves off and adds a 32K RAM card populated with 8K of RAM. Adding memory to the SYSTEM 2 is as easy as plugging memory chips on the 32K static RAM card. Each 8K additional RAM is $129. SYSTEM 2 costs $699, kit, and $899, assembled.

SYSTEM 3 combines a full 32K static RAM with a minifloppy disk drive, controller and DOS. Cost is $1499, kit, and $1799, assembled.

The 1K PROM monitor (MONBUG) at the heart of THE SYSTEM is compatible with the standard 6800 ROM (MIKBUG). As a result, virtually all 6800 software will run on THE SYSTEM. But MONBUG outputs to memory-mapped video cards permitting graphics, animation and an exclusive memory window.

MicroDaSys, PO Box 36051, Los Angeles CA 90036.

AIM Enclosures

Top off your Rockwell AIM-65 microcomputer with a new housing unit recently developed by the Enclosures Group. The SAE 1-1 Enclosure is thermoformed from Rohm and Haas kydex 100 for durability and safety. All mounting hardware is provided, and assembly takes only a few minutes using simple hand tools.

All switches are easily accessible, and paper-tape replacement is a cinch. A reset button actuation is built in. This black and gray enclosure retails for $43.75.

The Enclosures Group, 753 Bush St., San Francisco CA 94108, also manufactures and sells housings for the KIM-1 SYM-1 and Cherry-Pro keyboards.

SS-50 CPU Board

The CPU-2 is an SS-50 bus-compatible central processor board that uses the Motorola MC6802 Microprocessor IC, MC6850 ACIA, MC14411 baud rate generator and a MOS Technology MPS6532 memory-I/O-timer array. The board uses separate crystals for the baud rate generator and the 6802, has power-on reset, switch-selectable baud rates, RS-232 and current loop serial port and two 8-bit parallel I/O ports.

There is a 128 byte RAM at $F400 through $F47F for the stack and registers, as well as a 128 byte RAM at $0000 through $007F that can be used in small systems or disabled when external RAM at the same locations is used. Provision is made for an on-board 2708 or 2716 EPROM to provide 1K or 2K of ROM to contain an operating program or a monitor program.

This board can be used by itself in small measurement and control applications requiring up to 16 parallel I/O lines and one serial port. (The 14411, 6850, crystal, etc., can be left off if no serial port is needed.) The board can also be used in a fully expanded SS-50 bus system to address up to 62K of external RAM (3K is reserved for on-board uses). A preprogrammed monitor EPROM (FADBUG) is available. Bare board costs $35 each. Add $2.50 per order shipping and handling. Documentation is $5 ppd. Ohio residents, add 4 percent tax.

F & D Associates, 1270 Todd Rd., New Plymouth OH 45654.

Wiring Pencil Kit

A wiring pencil kit, Model 55X, offers a variety of tools and breadboarding hardware with an improved P178-1 wiring pencil with a 400-foot spool of 36-gauge insulated wire. During circuit construction, the wire is routed point to point, taking three turns around each post or lead where connections are made. When soldered with a 750° soldering iron, the insulation melts and a solder bond occurs.

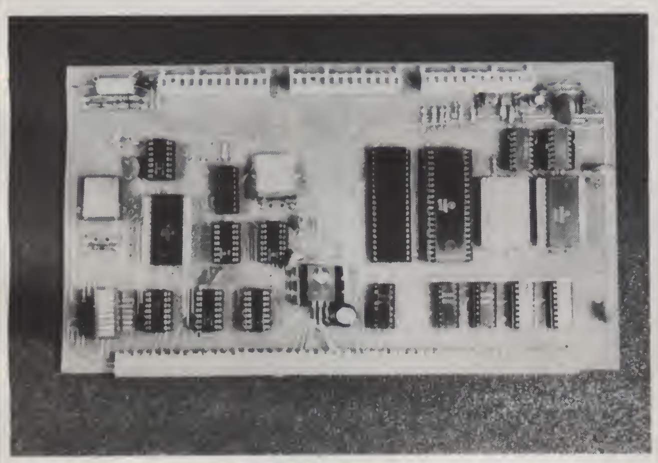
The tool is slim and lightweight with a comfortable tip angle for pencil-like wiring. Connections are three times faster than with conventional cut, strip and solder methods. The kit includes a wire-cutting chisel tool and a terminal installation tool as well as 120 feet of bare 30-gauge wire. Breadboarding supplies consist of 100 terminals, 20 wire spacers, an 8 inch by 4.5 inch Vectorbord, four pedestal feet for the board and a rigid foam support for terminal installation. The 55X kits are priced at $13.90 each, or the P178-1 pencils may be purchased separately for $7.95.

Vector Electronic Company, 12460 Gladstone Avenue, Sylmar CA 91342.

TRS-80 Disk Payroll

Hebbler Software Services, 7142 Elliott Drive, Dallas TX 75227, announces a line of business-related packaged pro-

(continued on page 22)



The CPU-2.

The P178-1 wiring tool.

LETTERS

PET Peeve

I just received the January 1979 issue of *Kilobaud MICROCOMPUTING* and wish to express my appreciation for your continuing high-quality magazine. But I am somewhat confused about your editorial policy with the inclusion of the first of a series written by Len Lindsay and titled "PET-pourri." As a biased and satisfied owner of the TRS-80 computer system, I think back to the July 1978 Editor's Remarks, "Where Have All the Forums Gone?" in which John Craig noted that the editors "decided to concentrate on articles for the variety of systems and do away with columns for certain ones" (p. 7). Thus the TRS-80 Forum, as well as columns focused on other systems, was discontinued.

Now don't misunderstand me. I think that "PET-pourri" is a well-written, interesting and important addition to the information available for both owners and non-owners of the PET computer. It is my hope that this editorial inconsistency will be cleared up. One way is to reinstate the TRS-80 Forum. The TRS-80 is the most cost efficient and widely owned microcomputer system and should be represented (as I said I am biased). Alternatively, the original editorial decision should be honored and a wide variety of articles should be published with no focus on any one system.

David L. Whelchel
Pullman WA

Due to the continuing lack of supporting documentation from Commodore, we felt that some method of disseminating the secrets of the PET was needed.—Editors.

Making Contacts

An examination of the circuit in Fig. 9 of "Baudot Interface Cookbook" (September 1978, p. 72) by J.R. Haglund and W.B. Reed revealed that a very low voltage was imposed across the contacts in the Teletype character encoder. Operation from the keyboard was adequate, but when I attempted operation from a tape, the result was a complete muddle, when any printout resulted at all. I decided that the voltage was too low for the sliding contact on the commutator. I revised the input circuit to a series connection to the 37 volt supply through a 5.6k Ohm resistor, with a shunt to ground of 1k Ohm across the input filter. This inverted the signal, so I added an extra inverter.

Gerald Matthews
Lanaka Harbor NJ

We feel that Mr. Matthews' note is worth publishing. Although we did not have any such trouble with our tape reader, I can see that a slightly dirty commutator would cause input problems as mentioned by Gerald.

Our trouble was not too low input voltage, but noise from the selector magnets. I feel that you should warn users to use the higher-voltage scheme only if they have problems with poor contacts in the Baudot.

W. B. Reed
Redwood City CA

No North?

What has North Star done wrong? They buy full-color ads in almost every issue, don't they? Look in the December issue. No Instant Software in North Star BASIC. No "North Star" or "Horizon" heading in the 1978 Index. I can only find two articles that have "North Star" in the title. I can only find two ads that offer NS BASIC software.

I really do not regret having plunked down money for a three-year subscription to *Kilobaud MICROCOMPUTING*. It really lives up to its motto. However, we users of NS BASIC would appreciate a little more attention.

Richard Kennon
Sunnyvale CA

Last month, we exhorted OSI and Apple owners to let us hear from them. (Oh, say, OSI-ers, see page 130.) Well—how about you North Star owners? (Meanwhile, check out Bob Goff's article on p. 100.) —Editors.

Fresh Perspective

I'm 11 years old and I read my father's computer magazines. I've also read Jade's catalog. I've drawn some pictures on what I think they mean (see below).

Amy Dolcourt
Sunnyvale CA

Service Sought

The article "A Service Bureau for Hobbyists" in the January 1979 issue of *Kilobaud MICROCOMPUTING* caught my interest. Because of it, I am seriously considering starting such a service. Initially, I plan to support cassettes, paper tape and probably a few types of floppy disks. Other initial services are likely to include printed listings and PROM programming.

I am interested in hearing from people with ideas on what services they would like. For example, what data formats are widely used? For cassettes this includes both recording format (Kansas City, etc.) and data formats (Intel's object format, etc.). What kinds of floppy disk systems should I support? What kind of services would be desirable? Possibilities here include copying from one medium to another, printing listings from cassettes, paper tape, etc., running assemblies or disassemblies, sorting data such as mailing lists and programming PROMs and listing their contents.

How much would people be willing to pay for some of these services? Would there be enough people using these services for me to stay in business? Is anyone else considering starting a hobbyist service bureau? Please let me know about any ideas or suggestions you may have.

James R. Howell
5472 Playa Del Rey
San Jose CA 95123

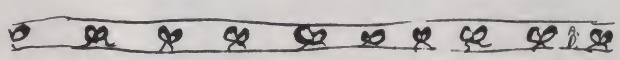
Cassette Tapes Revisited

I wish to clarify a point made in my December 1978 article, "The Care and Feeding of Cassette Tapes," which was brought to my attention by a Mr. B. Chudnor of Indiana. (I've misplaced his envelope and, consequently, his address; feel free to write me again, sir!)

I mentioned that the quality of remanence in tape is the same in all brands. May I repeat the word *quality*, for every tape brand has differing levels of this quality depending on how it is used.

I must also mention *retentivity*, another term used in judging magnetic tape, and its definition.

Retentivity is the ability of any substance to retain a magnetic charge. The soft iron core of a transformer, for example, has high magnetic properties when current is flowing, but does not remain magnetized after the cur-



Ribbon cable.

Heat sinks.

Number cruncher.

Reader Service—see page 179

rent has been removed . . . low retentivity. Remanence is the magnetic induction remaining in any substance after the magnetizing force has been removed.

Although tape remanence is the same for all brands, retentivity and coercivity, the measurement of the magnetic field strength required to establish a magnetic field in tape, are different for every brand.

It is all very simple, but sounds complex. If you vary the recording signal and its quality when recording, a tape's retentivity can affect playback; but by accounting for different tapes, the remanence will remain the same.

I had no desire to confuse anyone, instead I wished to mention in passing that all cassette tapes have something in common. The important point in my article concerns quality in tape today. Let me reiterate: Use a top-quality (always the higher priced) low-noise, high-output tape. The oxide coating is more even, dropouts are fewer, head wear is slower, flaking is less. The top-of-the-line tapes are usually contained in a better mechanical package allowing for smoother running tape and better tape-to-head contact.

Always buy a quality cassette. It will last longer and offer fewer hassles, both magnetically and mechanically

Lewis Tarnopol
Los Angeles CA

New Formula

I received a letter from Grace Taylor of Penn Valley PA correcting my depreciation formula in the December 1978 issue, p. 17 . . . the equation is wrong in the magazine. I've checked my handwritten copy of the letter and I think the student who typed it thought my "N" was a "2," since they do look somewhat alike the way that I write them. The equation should be:

$$D_t = \frac{N-t+1}{N(N+1)}2C$$

This is my fault, since I didn't check the letter closely before mailing it.

Jack Purdum
Indianapolis IN

Code in His Mind

Usually your articles are good and seem to be technically correct; but in Kilobaud Klassroom in the November 1978 issue, you allowed a bad situation to be described and to propagate.

The code mentioned is officially known as USASCII and has so been for many years. (Note: ASCII are people who cast no shadow—*Webster's Unabridged*.) [If anyone can translate this transcendentally cryptic statement, let us know.—Editors.]

The code is an *eight* information bit code. In the early days, only seven bits were used for information, and some manufacturers preempted—without "standards approval"—one bit for parity purposes. It is most important that users *not* believe that "ASCII is really only a 7-bit code." Such a belief makes use in editing (and other modes) of graphics currently available in most, if not all, character-generator ROMs unknown to the owner . . . and which number: 128 or more.

For instance, the TRS-80 will display 128 symbols and 64 6-bit blobs. To identify these, plus control codes in seven bits, is a mess of shifts and unshifts (don't forget 5-level code); and text editing with embedded shifts is rough.

In closing—I urge that we all forget this "bit eight is parity" nonsense and that we equip all keyboards with an *extended shift key* that enables bit 8.

Ancelme Roichel
Co-designer of the original ASCII, now USASCII, code
Pennington NJ

Update: "Update: Lunar Lander"

Mr. Shore's article in the August 1978 issue (p. 69) needs some sort of limit to the amount of thrust you can use. To "win" you merely have to coast (0 thrust) until the lander is almost on the moon, then give a burn equal to speed +5, and you make a landing at 0 ft/sec *every time*! Try adding 515 IF B 25 GOTO 500.

David Conley
Santee CA

I must agree wholeheartedly with Mr. Conley's comment about the lunar lander. Also, I suggest some other changes to enhance the program:

```
525  IF B<0 GOTO 500
604  LET C=V*2/3
606  PRINT "CRATER WAS ";C;" FT
     DEEP"
```

Malcolm Shore
Wellington
New Zealand

NEW PRODUCTS

(from page 19)

grams on disk for the Radio Shack TRS-80. The first release, Disk Payroll, is an interactive payroll system that handles any number of employees. The package features completely automated file handling, output options for the TRS-80 line printer and a comprehensive manual containing step-by-step instructions. Disk Payroll sells for $59.95.

Network Software

New software releases from the Network, 495 Third Avenue, San Francisco CA 94118, include:

CP/M for Cromemco Computers—A CBIOS for Cromemco 4FDC controller allows you to run all CP/M software on all Cromemco computers. Supplied on diskette with implementation instructions for $50 or sold with CP/M ready to run for $150.

Disk Utility Packages for CP/M or Cromemco—includes LISTF, which lists the directory to a disk file in the form of a SUBMIT or BATCH file, COPY, which copies and verifies an entire diskette in less than one minute on PerSci drives, TRAKTEST, which tests each track and sector for reading and writing, DISKTEST, which completely tests a diskette by writing and reading bit patterns, and COMPARE, which compares two diskette files. The entire package supplied on diskette complete with documentation costs $50.

Blackjack—instructs the player on the basic strategy originated by Professor Edward Thorp against a single deck using Las Vegas rules. Runs under CBASIC or Microsoft BASIC and is supplied on diskette or listing for $25.

All programs are available at Database, PO Box 22212, San Francisco CA 94122.

Hard Disk from Imsai

HD-10 Hard Disk Systems, featuring the CDC Hawk Model 9427H hard disk, provide 10 megabytes of formatted on-line storage per unit. The 9427H is a high-performance, random access storage device that uses a single fixed disk for 5 megabytes of storage. An industry standard 5440-type removable disk cartridge provides an additional 5 megabytes of storage. This removable media capability allows for file backup and unlimited off-line storage. Average random access time is under 35 milliseconds.

HD-10 is compatible with all Imsai 8080/85-based microcomputers. The system employs a single S-100 bus I/O board to interface with up to two external disk controllers. Each controller supports up to four hard disks. Therefore, any Imsai system may be expanded to 80 megabytes of hard disk storage with only one I/O card.

Included with the HD-10 system is the new IMDOS II operating system. Any applications written under IMDOS will run under IMDOS II with little or no modification. Simply assign the hard disk as the logical device used by the application. All of Imsai's utilities and languages will also run. IMDOS II is compatible with other versions of IMDOS and CP/M version 1.33.

Imsai Manufacturing Corporation, 14860 Wicks Blvd., San Leandro CA 94577.

PUBLISHER'S REMARKS

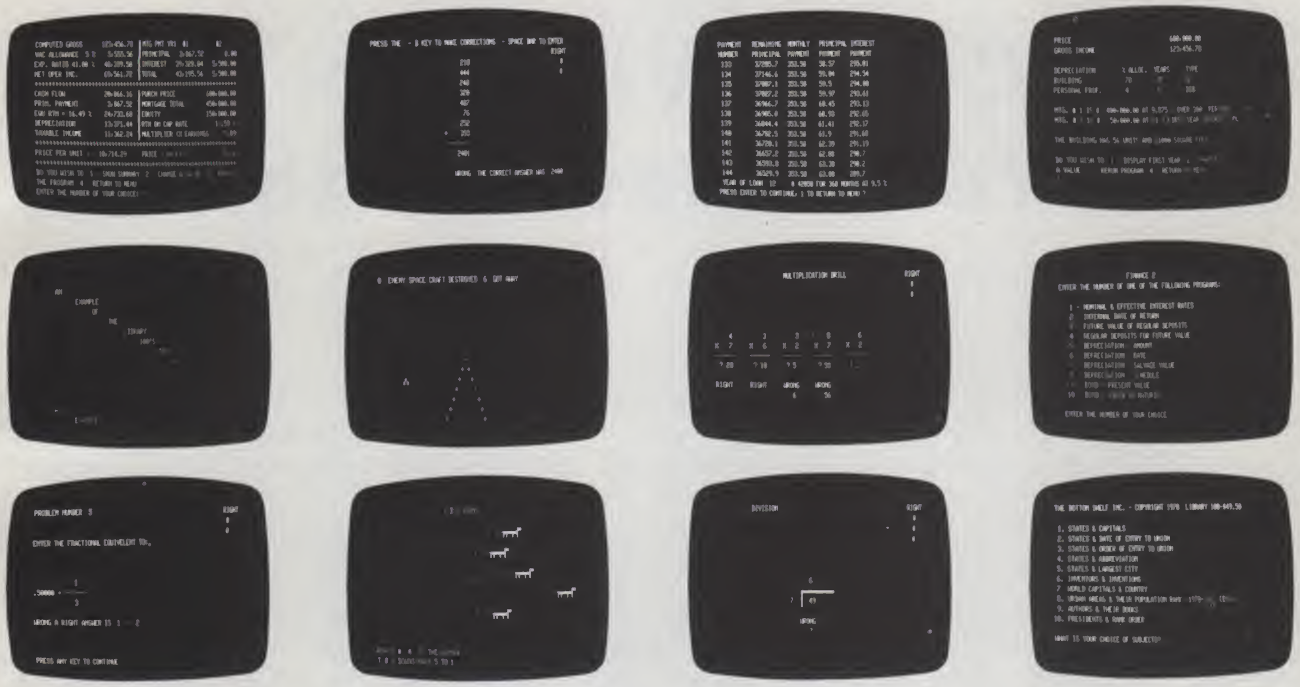
(from page 6)

clean . . . not too cold in winter and not too hot in summer. It is beautiful up here in the mountains. Peterborough is a small town and it is going to stay a small town. Most of the people who work here live in neighboring communities where they have plenty of land so they can live a rural life instead of all piled together in suburban tracts or apartment houses.

Salaries? We'll pay enough for you to make do, and when we make money you'll share in it in proportion to your contribution to that prosperity.

Level II TRS-80 + The LIBRARY 100

You shouldn't have one without the other!!



Finance: Present Value of a Future Sum—Simple Interest for Days—Future Value of a Present Sum—Amortization Schedule—Interest Rate: Compound Interest—Interest Rate: Installment Loan—Days Between Dates—Term of an Installment Loan—Present Value of a Series of Payments—Real Estate Capital Investment—Nominal and Effective Interest Rates—Internal Rate of Return—Future Value of Regular Deposits—Regular Deposits for Future Value—Depreciation Amount: Rate; Salvage Value; Schedule—Bond Present Value—Bond Yield to Maturity—Sale—Cost—Margin—Day of the Week—Moving Ad.
Education: Multiplication & Division—Add—Subtract—Fraction & Decimal—States & Capitals—States & Order of Entry—States & Abbreviation—Inventors & Inventions—World Capitals & Countries—Urban Areas & Population—Authors & Books—Presidents & Order—States & Largest City—Basenum.
Graphics: Left Right—Random Ad—Graphic—Blocks—Fireside—Snow—Step Ad—Step Ad 2—Launch—Ratrace—War Game—Weird—Herring—Blinker—Snoopy.
Home: Message Board—Expense Account—Nutrition—Mileage—Remember—Phone Codes—Night Check Off—Drunkometer—Perpetual Calendar—Babysitter—Calculator—Bartender—Christmas List—Vacation Check Off—Conversion.
Games: Speedy—Odd One—R. Roulette—Star Blazer—Search—Spyship—Tiger Shark—Jumble 2—Sting Ray—Stars—Sketch—Flipper—Scissors—Horse—Doomsday—Craps—Jumble 1—Mem. Quiz Letters—Mem. Quiz Numbers—Wheel of Fortune—Decision—Unjumble—Fifteen—Towers—Life—Star Trek—Race Track—Count—Roachrace—Gypsy.

The Library 100 is the best buy in software history! We do have one problem, though. Some people cannot believe that we can give you so much for only $49.50. We suggest that if you don't believe it, you ask your friends who have purchased this software package or go to your local computer store and ask to see it.

The Library 100 is a collection of 100 original, quality programs, plus a new, easy programming language for your TRS-80, Tiny PILOT (TPILOT).

It took us 37 pages in our manual just to say a little about each program, so we cannot describe them all here. We did list them. How many can you use?

You've read the announcements in Kilobaud and Creative Computing. It is here and it is real. A value in excess of $500.00 for only $49.50 plus $2.00 postage and handling (plus 4% for Georgia residents).

Watch for future software announcements. Hardware? Calculator? Business systems? Write and tell us what you want next.

Mail: $49.50 + $2.00 P & H + 4% if shipped to Georgia.

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See: Your local computer store or Radio Shack Associate Store.

VISA master charge

TBS INC.

The Bottom Shelf, Inc.
P.O. Box 49104
Atlanta, Georgia 30359 B44

Reader Service—see page 179

Don Lancaster
Synergetics

Cheap Video for Your Heathkit H8

Here's a first look at part of Don Lancaster's latest Sams book, Son of Cheap Video. *The TV 6-5/8 he talks about is a full graphics update of the original TVT-6L we ran in the June 1977 issue of* Kilobaud, *is a PAIA kit and is detailed in Lancaster's* Cheap Video Cookbook.

You'll find things more challenging when you add cheap video to an 8080 or Z-80 system, compared to the easy 6500 conversions. There are several new hassles involved that will get in your way and somehow have to be resolved.

In most cases, these hassles will take extra coding, more low-cost ICs and very careful attention to your system timing. The bottom line is this: Cheap video *should* go on most any 8080 or Z-80 system, but it will take more effort, more code and more parts to get comparable results.

Let's see just what these hassles are. First, we'll look at an 8080 in general to see what the hardware and software differences will be. Then we'll check into a general-use 8080/Z-80 adapter that goes between your computer and the TVT 6-5/8. Finally, we'll show you the software you will need to put cheap video on a Heathkit H8.

We'll assume your system is bus oriented and that your cheap video system is to be a piggyback add-on to an existing RAM plug-in card. We'll further assume the usual 2 MHz 8080 speed. Your RAM should be fast enough that it does not use the READY command to hold up CPU time. We'll also assume your system is big enough that nonvolatile scan firmware is more important than minimizing the total words of scan coding.

Be forewarned that what we are going to look at has only been tested on the Benton Harbor 50-pin bus. While there is no obvious reason why you can't do the same thing on an S-100 bus system or with a Z-80, we have not tried it just yet, and neither should you . . . unless you have a good triggered scope on hand and thoroughly understand the 8080 CPU timing.

Our main 8080 hassles are these:

1. The address bus has garbage on it at times.
2. The program counter usually can change only once every *two* microseconds. This is only half as fast as we need for a reasonable number of characters or chunks on a line.
3. Clocking and timing signals are different.
4. Literal translation of scan programs will be far too slow.

In general, we'll get around hassle #1 by latching and holding both address and upstream tap data lines using suitably spaced timing. We'll beat #2 by adding a "speed doubling" circuit that creates the *illusion* of a once-per-microsecond program counter advance. This illusion will appear only at the display memory and then only

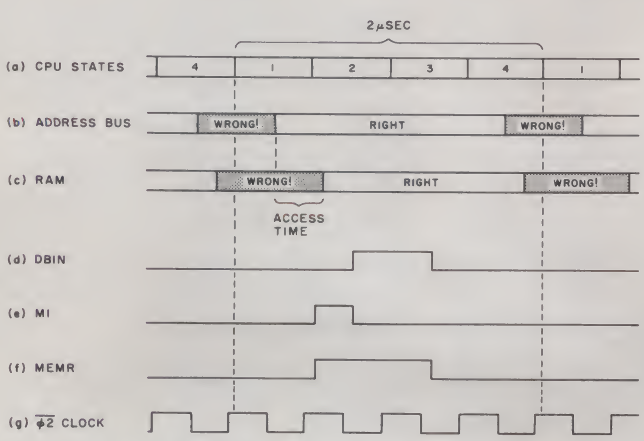

Fig. 1. The H8 is a typical 2 MHz 8080A system. Here are the waveforms involved in reading a NOP command out of RAM.

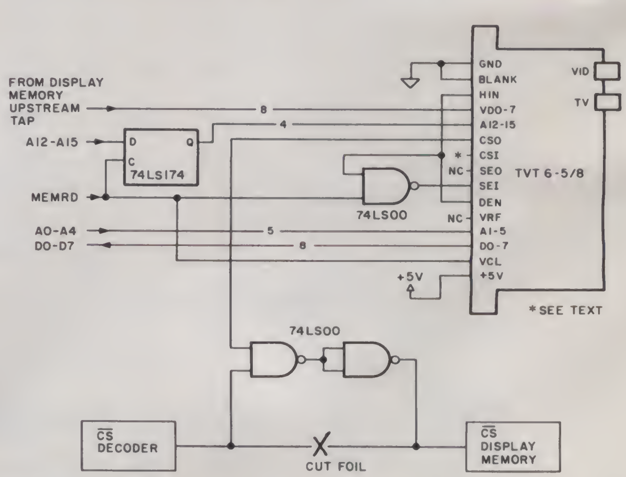

Fig. 2. Minimum 8080A-TVT 6-5/8 interface is limited to 2 usec character or chunk times.

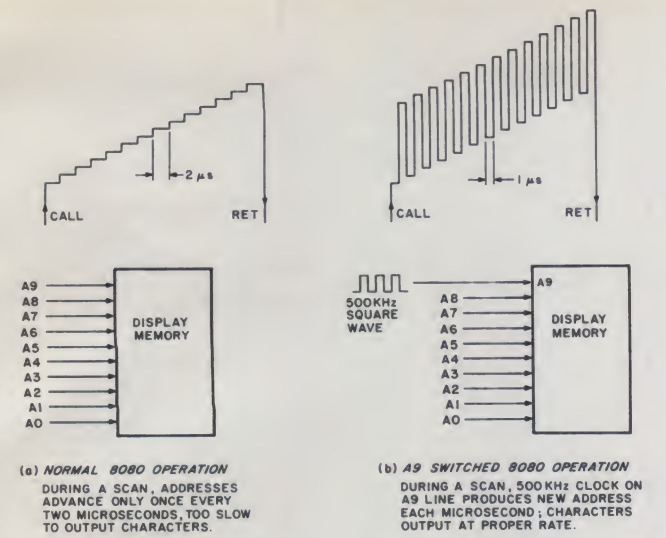

Fig. 3. A stock 8080 system can't change display memory addresses each microsecond. Here's how to use A9 switching for speedup.

during a TVT scan. Everything else stays the usual speed. Hassle #3 goes away when we solve #2. Finally, we can get scan software that is fast enough by using the powerful register-to-register commands of the 8080 or by using brute force (all ROM, non-modifying) coding.

On to the fine print.

Hardware

Suppose we have a normal, functional H8 executing a string of no *operations* (NOP) from a plug-in RAM card. What will this timing look like? How can we trick the H8 into using the same sort of timing—with add-ons—to run a TVT 6-5/8? Fig. 1 gives us some clues.

Execution of a NOP takes two microseconds (actually, slightly less than this on the H8). Four CPU states (Fig. 1a), each taking around half a microsecond, are involved. The object of these four states is to put the program counter on the address bus, read an addressed memory location, enter it into the CPU and then act on the command. When the CPU finds out the command is a NOP, it will spend the tail end of the cycle essentially doing nothing.

Our first hassle appears in Fig. 1b. We see that the address bus only has the correct information on it three-quarters of the time. For the remaining quarter of the time, the address bus has invalid information on it. Now, if we address a memory with the wrong address, we will, of course, get the wrong information out of the memory. Worse still, since the memory has its own access time to contend with, the amount of time that useful information comes out of the memory is even shorter than the time the address bus is valid (Fig. 1c). So, the bad news is that both data and address have all kinds of holes in them and don't seem directly usable.

There are some system-level signals that may help us out of this bind. Signal DBIN in Fig. 1d determines the time when the CPU *must* have valid data; but this signal is not available on the system bus . . . for a very good reason. Anyone who tries to use this signal will be cutting into the CPU's *own* processing time and degrading performance. Instead, two signals are derived for bus use. These signals occur early enough so that enables, decoding, settling times and so on are complete before the CPU needs valid data. These signals are called M1 (Fig. 1e) and MEMR (Fig. 1f).

M1 starts after the address is valid but ends before DBIN. MEMR includes both the M1 and DBIN times. *Unfortunately, both M1 and MEMR start before we are sure that the memory is outputting valid data*. The theory here is that output enables and bus access can take place during the *same* time that the memory is still accessing itself, so long as everything ends up stable by the start of DBIN time. A final waveform we will find useful is the $\overline{\emptyset 2}$ system clock shown in Fig. 1g.

The least we can get away with and still get cheap video on an 8080 is latching the upper four address lines. If we don't do this, all the commands out of our TVT instruction decoder PROM, including the row commands and the sync pulses, will have big holes chopped in them.

Fig. 2 shows a minimum 8080-to-TVT 6-5/8 interface. In this circuit, +5, ground, blanking, the upstream tap and the data bus are connected in the usual way. Address lines A12 through A15 are connected to a latch that catches the valid addresses. This is done on the *leading edge* of the memory read command, MEMR.

Our chip select output CSO is shown going to an AND gate that gives us an external negative logic OR combination of the old display memory chip select and the one needed for TVT scanning. A foil cut is involved here. The chip select input, CSI, is shown permanently enabled. Depending on your decode PROM, this can go to a TVT enable switch, do nothing or be used as an internal chip select combiner, eliminating the external gate.

The TVT is only allowed to gain data bus control during a scan and then only when the computer wants to read it. To do this, we use the computer's memory read MEMR command and NAND it with the decode enable, DEN, to get a suitable scan enable SEI input.

MEMR also goes to the clock input of the TVT 6-5/8. But, since our load command in the TVT is derived from the *falling* edge of VCL, it is the *trailing* edge of MEMR that loads our video shift register. The time difference of about 750 nanoseconds gives our character generator more than enough time to produce a valid output.

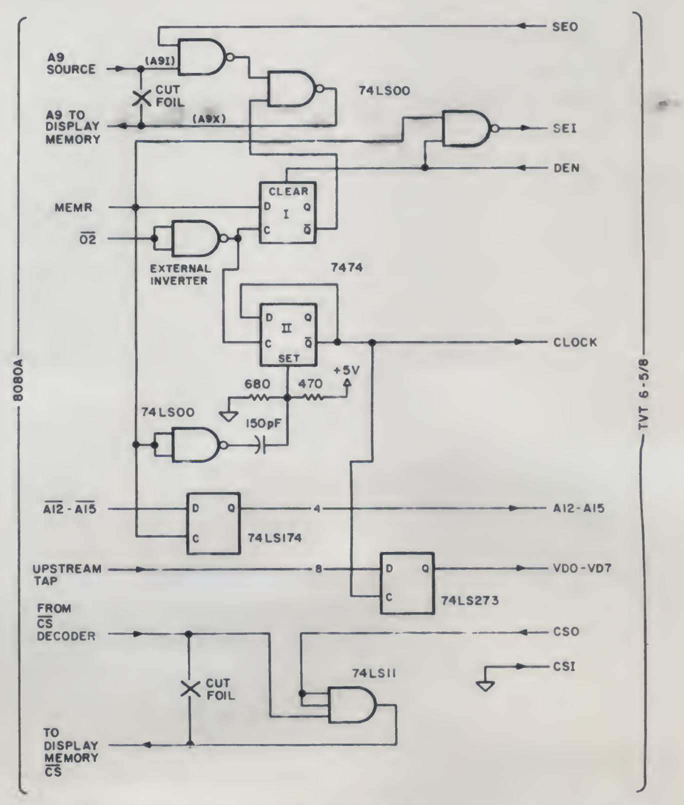

Fig. 4. Speed-doubling 8080A-TVT 6-5/8 interface gives 1 usec character or chunk times.

Now, this is a quick and dirty circuit that you may want to try just to get *some* video out of your 8080 in a hurry. But, there are several problems we still have to attack to get something good enough for final system use.

One minor hang-up is that you may only have complements of your data bus or address bus available. We'll soon see how to change the coding in your Scan and Decode PROMs to get around this. The coding, of course, has to be changed anyway since the 8080 gets all bent out of shape when it receives 6502 commands. Inverters or inverting gates can also be used to invert bus, clock, data or control lines as needed.

The big hassle is that the character or chunk times will be *two* microseconds each, rather than just one. This means that, so far, even a 32 character line won't run at normal horizontal scan frequencies. Beating this particular hassle soundly about the head and ears is the key to practical cheap video on the 8080.

But how?

Speed Doubling Via A9 Switching

We want to get our chunk and character times down to a decent rate of one microsecond. We can either speed up the microprocessor or else do something else that creates the *illusion* of a microprocessor speedup at the display memory and in the adapter circuits.

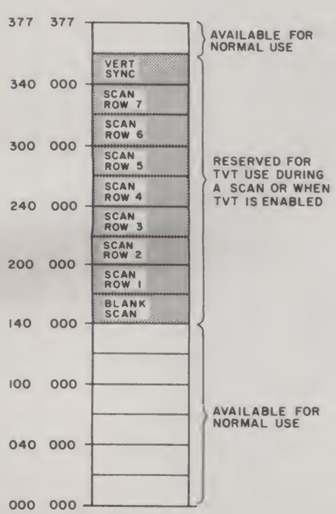

Fig. 6. H8 address map.

Speedup may be easy for you if you have a Z-80, provided your display memory is also fast enough to not use the READY command. If you do run faster, you probably would like to latch the upstream tap data to make sure you have enough processing time for your character generator. While a simple speedup will work in some systems, there is a much better way called *A9 switching*.

The object of A9 switching is to create the *illusion* of a once-per-microsecond address advance at the display memory. Fig. 3 gives us details on how this works. We break our most significant display space address line and connect it to a carefully timed 500 kHz square wave during a scan. For a 16 × 64 or a 12 × 80 alphanumeric display, this will be address line A9.

Now, a 500 kHz square wave is low for one microsecond and high for another one. While all the regular addresses *below* A9 are changing at their usual two-microsecond rate, A9 is busy addressing one character or chunk location on the first microsecond and another location on the second. Thus, we get characters or chunks out of our display memory at a one-per-microsecond speed.

But why on earth use A9? Wouldn't it be simpler to use A0 instead? If we do this, we would have to add an address multiplexer to all inputs of the display memory—a 10-pole double throw switch or its Tri-state equivalent. This is obviously something we want to avoid if we are piggybacking video onto an existing memory card. All A9 switching takes a single foil cut and some add-on wires to the memory card.

There is a catch. It is a "yeah-but" rather than a "gotcha." *The characters and chunks are no longer in the display memory in sequential order if you use A9 switching.* So, your cursor or controlling loader software has to have a few words added to complement A9 each successive location.

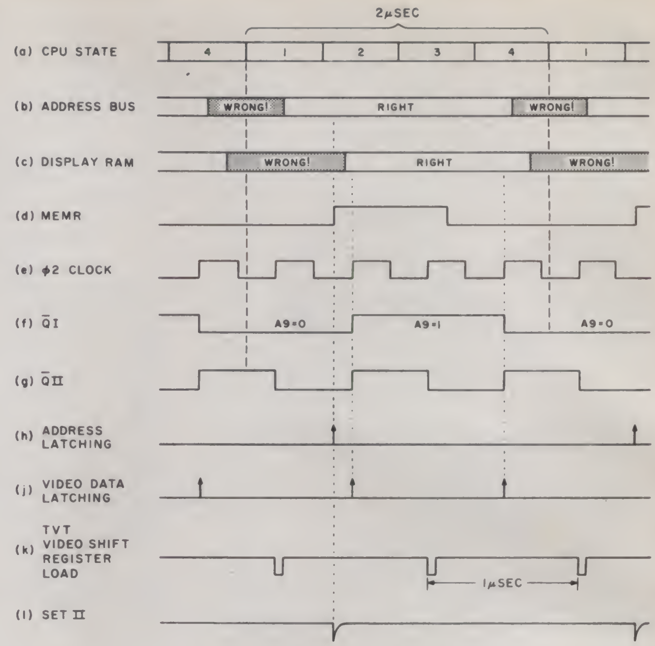

Fig. 5. Speed-doubling waveforms.

For instance, say your display memory starts at 000 000. The next character or chunk will be at 002 000. Your characters will follow in this order:

1st character	000 000
2nd character	002 000
3rd character	000 001
4th character	002 001
5th character	000 002
6th character	002 002
.	.
.	.
.	.
1022nd character	003 376
1023rd character	001 377
1024th character	003 377

This seems awful, but it works. And it is a simple way to double the apparent memory access speed of an 8080 so we can get information out of RAM once per microsecond under block access. And all it takes to do the job is some simple hardware between computer and TVT, a few software words and one extra foil cut on the memory. The hardware involved is shown in Fig. 4, along with the timing details of Fig. 5.

Two new D-flip-flops are added to our interface. The first delays and expands the MEMR signal to give us a controlled phase 500 kHz square wave we can use for the speed doubling A9 address switching. The second divides the system clock by two and is used to latch the video data and to provide a TVT clock.

Waveforms (a), (b), (c) and (d) in Fig. 5 are as before. Waveform (e) is a Ø2 clock, which has to be an inverted replica of the Heath bus $\overline{Ø2}$ clock signal. Waveform (f) shows us the 500 kHz square wave that results when we clock MEMR. Since the clocking is delayed from the MEMR leading edge, the flip-flop's output is wider than MEMR and is almost a microsecond long. This results in a square wave that is low for one microsecond and high for the next, locked to (but following) MEMR.

This particular flip-flop is only allowed to run *during* a scan. Otherwise, it is held high by DEN. The uppermost two gates combine the old A9 information with the speed-doubling new A9 signal, acting as a single pole, double throw selector switch. During computer times, the display memory *A9 line is* connected to the computer. During scan microinstruction times, the display memory A9 line is connected so it is low for one microsecond and high for the next.

Waveform (g) shows us the one megahertz clock we get by dividing down Ø2. This clock is used to sample and latch the display memory output immediately after the data is valid and then latch again one microsecond later, well after the A9

658-HD8
PROM NUMBER

□ = "0" ■ = "1"
(POSITIVE LOGIC)

USE FOR TVT 6-5/8 ON AN 8080 SYSTEM WITH INVERTED $\overline{A12}$, $\overline{A13}$, $\overline{A14}$, $\overline{A15}$ LINES.

CG LINE "2" IS USED AS GRAPHICS "BLANKING" OUTPUT.

CG LINE "4" IS USED AS GRAPHICS "UPPER-LOWER" CHUNK SELECT OUTPUT.

	INPUTS			OUTPUTS							
	WORD #	WHAT DOES THIS WORD DO?	HEX OP-CODE	Q8 CS OUT	Q7 SCAN ENABLE	Q6 DECODE ENABLE	Q5 VERTICAL SYNC	Q4 (SPARE)	Q3 CG LINE "4"	Q2 CG LINE "2"	Q1 CG LINE "1"
TVT ENABLED	0	NORMAL	Cϕ	■	■	□	□	□	□	□	□
	1	VERTICAL SYNC	dϕ	■	■	□	■	□	□	□	□
	2	LINE 7 SCAN	27	□	□	■	□	□	■	■	■
	3	LINE 6 SCAN	26	□	□	■	□	□	■	■	□
	4	LINE 5 SCAN	25	□	□	■	□	□	■	□	■
	5	LINE 4 SCAN	24	□	□	■	□	□	■	□	□
	6	LINE 3 SCAN	23	□	□	■	□	□	□	■	■
	7	LINE 2 SCAN	22	□	□	■	□	□	□	■	□
	8	LINE 1 SCAN	21	□	□	■	□	□	□	□	■
	9	BLANK SCAN	20	□	□	■	□	□	□	□	□
	10	NORMAL	CO	■	■	□	□	□	□	□	□
	11	NORMAL	CO	■	■	□	□	□	□	□	□
	12	NORMAL	CO	■	■	□	□	□	□	□	□
	13	NORMAL	CO	■	■	□	□	□	□	□	□
	14	NORMAL	CO	■	■	□	□	□	□	□	□
	15	NORMAL	CO	■	■	□	□	□	□	□	□
TVT DISABLED	16	NORMAL	CO	■	■	□	□	□	□	□	□
	17	NORMAL	CO	■	■	□	□	□	□	□	□
	18	NORMAL	CO	■	■	□	□	□	□	□	□
	19	NORMAL	CO	■	■	□	□	□	□	□	□
	20	NORMAL	CO	■	■	□	□	□	□	□	□
	21	NORMAL	CO	■	■	□	□	□	□	□	□
	22	NORMAL	CO	■	■	□	□	□	□	□	□
	23	NORMAL	CO	■	■	□	□	□	□	□	□
	24	NORMAL	CO	■	■	□	□	□	□	□	□
	25	NORMAL	CO	■	■	□	□	□	□	□	□
	26	NORMAL	CO	■	■	□	□	□	□	□	□
	27	NORMAL	CO	■	■	□	□	□	□	□	□
	28	NORMAL	CO	■	■	□	□	□	□	□	□
	29	NORMAL	CO	■	■	□	□	□	□	□	□
	30	NORMAL	CO	■	■	□	□	□	□	□	□
	31	NORMAL	CO	■	■	□	□	□	□	□	□

Fig. 7. Truth table for 8080 Decode PROM having inverted address inputs (used on Heathkit H8).

change has been accepted. The first sample gives us an A9 = 0 data value, while the second handles the A9 = 1 case. The TVT's video shift register is clocked on the falling edge of this one megahertz clock. Since there is a one-half microsecond delay between the leading and trailing clock edges, enough time is available for the character generator or the data-to-video converter to accept the latched video data and process it.

Our A9-generating flip-flop automatically initializes itself on MEMR since it is simply delaying this signal. But the clock-dividing flip-flop can be in either state at the *beginning* of a scan microinstruction. Unless we somehow initialize this flip-flop to the right state, we'll get garbage out of the display memory caused by sampling at the wrong times.

We initialize this clock-dividing flip-flop by inverting MEMR and using the leading edge to SET the divide flip-flop to the desired state. This initialization is very important since the usual CALL instruction preceding the scan microinstruction has an odd number of clock cycles in it.

TVT scan enabling and the display memory chip selecting are done the same way as the slower interface of Fig. 2. We enable the TVT Scan Enable Input (SEI) only during MEMR time to give us data for a scan microinstruction only when it is called for and only when the computer will allow data bus access. The display memory chip select is a negative logic OR of the computer's chip select and the CSO that the TVT provides.

Our speed doubling interface takes two foil cuts on the memory board—one on the A9 address line and one on the chip select line. All other connections are add-ons derived from signals available on a typical plug-in memory card. Five low-cost integrated circuits are involved in this particular adapter.

Software

Let's take a look at the PROM firmware and some of the software involved in getting cheap video on your 8080A system. For right now, we'll stick to the older address-mapped and subroutine-scanned methods we used in the *Cheap Video Cookbook.* Most likely you can simplify things a great deal by going to the Scungy Video* route of break-mapping and interrupt-scanning. The strong Input/Output commands in the 8080A make this a very attractive idea.

If you use address mapping, refer to the computer memory map shown in Fig. 6. A block of addresses from 6K to 60K is reserved for TVT use when the TVT is enabled. On the H8, this leaves the bottom 8K for the PAM monitor and operating system and 16K for enough RAM to hold a display memory and run Extended BASIC at the same time. The uppermost 4K of addresses are also available as needed.

Should you want more address space for other uses, you can use the TVT enable to free addresses during non-display times. You can also go the Scungy Video route and use I/O instructions and a parallel port instead of address mapping the row commands. Yet another alternative is to use further decoding to activate the TVT only during valid display memory addresses. For instance, if you are only using 1K of display memory, 3K of all the scan blocks can be used for other

*Scungy Video is an alternate method and is detailed in Chapter 1 of *Son of Cheap Video*.

658-HS64
PROM NUMBER

□ = "0" ■ = "1"
(POSITIVE LOGIC)

USE FOR TVT 6-5/8 ON AN 8080 SYSTEM WITH TRUE A0-A7 LINES AND INVERTED DATA BUS NO REPACKING

INPUTS			OUTPUTS							
WORD #	WHAT DOES THIS WORD DO?	HEX OP-CODE	Q8 DB7	Q7 DB6	Q6 DB5	Q5 DB4	Q4 DB3	Q3 DB2	Q2 DB1	Q1 DB0
0	NOP	FF	■	■	■	■	■	■	■	■
1	NOP	FF	■	■	■	■	■	■	■	■
2	NOP	FF	■	■	■	■	■	■	■	■
3	NOP	FF	■	■	■	■	■	■	■	■
4	NOP	FF	■	■	■	■	■	■	■	■
5	NOP	FF	■	■	■	■	■	■	■	■
6	NOP	FF	■	■	■	■	■	■	■	■
7	NOP	FF	■	■	■	■	■	■	■	■
8	NOP	FF	■	■	■	■	■	■	■	■
9	NOP	FF	■	■	■	■	■	■	■	■
10	NOP	FF	■	■	■	■	■	■	■	■
11	NOP	FF	■	■	■	■	■	■	■	■
12	NOP	FF	■	■	■	■	■	■	■	■
13	NOP	FF	■	■	■	■	■	■	■	■
14	NOP	FF	■	■	■	■	■	■	■	■
15	NOP	FF	■	■	■	■	■	■	■	■
16	NOP	FF	■	■	■	■	■	■	■	■
17	NOP	FF	■	■	■	■	■	■	■	■
18	NOP	FF	■	■	■	■	■	■	■	■
19	NOP	FF	■	■	■	■	■	■	■	■
20	NOP	FF	■	■	■	■	■	■	■	■
21	NOP	FF	■	■	■	■	■	■	■	■
22	NOP	FF	■	■	■	■	■	■	■	■
23	NOP	FF	■	■	■	■	■	■	■	■
24	NOP	FF	■	■	■	■	■	■	■	■
25	NOP	FF	■	■	■	■	■	■	■	■
26	NOP	FF	■	■	■	■	■	■	■	■
27	NOP	FF	■	■	■	■	■	■	■	■
28	NOP	FF	■	■	■	■	■	■	■	■
29	NOP	FF	■	■	■	■	■	■	■	■
30	NOP	FF	■	■	■	■	■	■	■	■
31	RET	36	□	□	■	■	□	■	■	□

Fig. 8. Truth table for 8080 Scan PROM having no repacking, true address inputs and inverted data outputs.

658-HS80
PROM NUMBER

□ = "0" ■ = "1"
(POSITIVE LOGIC)

USE ONLY FOR 80 CHARACTER REPACKED LINES ON AN 8080 SYSTEM WITH TRUE A0-A7 LINES AND INVERTED DATA BUS.

INPUTS			OUTPUTS							
			Q8	Q7	Q6	Q5	Q4	Q3	Q2	Q1
WORD #	WHAT DOES THIS WORD DO?	HEX OP-CODE	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	NOP	FF	■	■	■	■	■	■	■	■
1	NOP	FF	■	■	■	■	■	■	■	■
2	NOP	FF	■	■	■	■	■	■	■	■
3	NOP	FF	■	■	■	■	■	■	■	■
4	NOP	FF	■	■	■	■	■	■	■	■
5	NOP	FF	■	■	■	■	■	■	■	■
6	NOP	FF	■	■	■	■	■	■	■	■
7	NOP	FF	■	■	■	■	■	■	■	■
8	NOP	FF	■	■	■	■	■	■	■	■
9	NOP	FF	■	■	■	■	■	■	■	■
10	NOP	FF	■	■	■	■	■	■	■	■
11	RET	36	□	□	■	■	□	■	■	□
12	NOP	FF	■	■	■	■	■	■	■	■
13	NOP	FF	■	■	■	■	■	■	■	■
14	NOP	FF	■	■	■	■	■	■	■	■
15	NOP	FF	■	■	■	■	■	■	■	■
16	NOP	FF	■	■	■	■	■	■	■	■
17	NOP	FF	■	■	■	■	■	■	■	■
18	NOP	FF	■	■	■	■	■	■	■	■
19	NOP	FF	■	■	■	■	■	■	■	■
20	NOP	FF	■	■	■	■	■	■	■	■
21	RET	36	□	□	■	■	□	■	■	□
22	NOP	FF	■	■	■	■	■	■	■	■
23	NOP	FF	■	■	■	■	■	■	■	■
24	NOP	FF	■	■	■	■	■	■	■	■
25	NOP	FF	■	■	■	■	■	■	■	■
26	NOP	FF	■	■	■	■	■	■	■	■
27	NOP	FF	■	■	■	■	■	■	■	■
28	NOP	FF	■	■	■	■	■	■	■	■
29	NOP	FF	■	■	■	■	■	■	■	■
30	NOP	FF	■	■	■	■	■	■	■	■
31	RET	36	□	□	■	■	□	■	■	□

Fig. 9. Truth table for 80 character 8080 Scan PROM (true address inputs, inverted data outputs).

purposes if you add suitable decoding.

A quick look at the H8-3 memory board shows that only some of the address and data lines are available in their true form; most of them are inverted. The data-out buffer on this memory card must be disabled for the upstream tap needed by cheap video. This means that the output of our Scan Microinstruction PROM has to directly drive the system data bus and thus must output inverted (negative logic) data. We also see that address lines A13, A14 and A15 aren't available except as complements. The simplest way out of this situation is to code our *Decode* PROM to respond directly to complemented addresses.

Fig. 7 shows us the H8 Decode PROM truth table, 658-HD8. We input lines $\overline{A12}$, $\overline{A13}$, $\overline{A14}$ and $\overline{A15}$, along with a TVT enable using the old CSI line. This PROM outputs code to the row commands of the character generator or else routes blanking and selection commands to a graphics data-to-video converter. The Decode PROM also outputs system controlling signals DEN, SEO, CSO and the vertical sync VRF pulses.

Since we are using complemented address inputs, this PROM runs "backwards" from the earlier PROMs we looked at. The net result of a "frontwards" PROM with true address inputs or a "backwards" PROM with inverted address inputs is the same.

Holding the CSI line positive disables the TVT and frees most all addresses for other uses. Grounding CSI enables the TVT scanning and reserves the needed address blocks for TVT use. This particular PROM coding needs an external AND gate for chip selection and combination.

There are two types of *Scan* PROM coding we might like to use, depending on whether we are using "binary" line lengths or are repacking "non-binary" line lengths for maximum memory efficiency. Fig. 8 shows a Scan PROM coding intended for 64 character lines, but usable for 32 character lines, most graphics and other lengths *without* memory repacking. This is numbered 658-HS64.

We use a NOP to advance the program counter in the computer and an RET coding to return from the called scan microinstruction. Since we are outputting complemented data, these outputs are inverted. On the H8, address lines A0 through A6 are available in true form, so we do not have to complement the address inputs. Thus, our Scan PROMs run "frontwards" but output complemented code.

We can use the 658-HS80 Scan PROM truth table in Fig. 9 for memory repacked scans of 80 characters per line, three lines per page. Once again, this PROM coding is driven by true addresses and outputs complementary data directly to the H8 $\overline{\text{data}}$ bus.

Our address lines are connected differently on an 8080 system than on a 6502. Remember that we used every *second* address change on the 6502 to advance our Scan PROM *one* count. On an 8080 we use *every* address change to advance the Scan PROM *one* count, but use A9 switching to get two characters out of memory per one Scan PROM count advance. Either way, the Scan PROM responds to an input address change once every *two* microseconds, and everything comes out even.

This means that, in general on an 8080 system, the Scan PROM's inputs are usually connected to one address line *less* than usual for a 6502 system. Fig. 10 shows our address line management for an 8080 adapter. It also shows how two new switches can be added along with a gate to let you use either a 658-HS64 or a 658-HS80 Scan PROM on an 8080 system without needing any rewiring.

Several examples will show how this address management works.

1. For 32 character lines using speed doubling, use PROM 658-HS64 and set your switches to A4 = " + ," A5 = " + " and "32."
2. For 64 character lines using speed doubling, use PROM 658-HS64 and set your switches to A4 = "A4," A5 = " + " and "32."
3. For 80 character lines using speed doubling and memory repacking, use PROM 658-HS80 and set your switches to A4 = "A4," A5 = "A5" and "64."

In our first example, the upper half of a Scan PROM is cycled through in 16 counts lasting 32 microseconds. In the second example, the entire Scan PROM is cycled through in 32 counts lasting 64 microseconds. In the final example, if we wanted to, the entire Scan PROM could be scanned in 32 counts lasting 256 microseconds. But with memory repacking and A9 switching, we only use slightly under a third of the 80 line Scan PROM *per scan*, ending up with ten counts per scan lasting 80 microseconds.

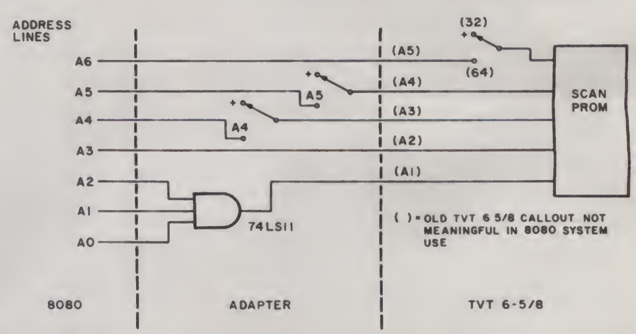

Fig. 10. The Scan PROM address inputs on the TVT 6-5/8 have to be redefined for 8080 use. The gate and switches let you run ordinary or repacked memory PROMs without wire changes.

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SPECIFICATIONS

DISPLAY

SCREEN CAPACITY, CHARACTERS	2000
CHARACTERS PER LINE	80
NUMBER OF LINES	25
SCREEN	P4 phosphor (white)
TUBE SIZE(DIAGONAL)	12 inches (30.4 cm)
VIEWING AREA	54 square inches (137.1 cm)
CHARACTER SIZE	0.20" high x .08" wide (5.08 mm high x 2.03 mm wide)
REFRESH RATE	60 Hz (50 Hz available)
SCAN METHOD	Raster
CHARACTER GENERATION	5 x 7 character in an 8 x 10 dot matrix
CURSOR	Blinking block

MEMORY

TYPE	Random Access Memory
CAPACITY	2000 characters

OPERATOR CONTROLS

POWER ON/OFF SWITCH	On rear of unit
BRIGHTNESS CONTROL	On rear of unit

POWER REQUIREMENTS

Model 501 — 115 volts, 60 Hz, 100 watts nominal
Model 502 — 230 volts, 50 Hz, 100 watts nominal

INTERFACE

DATA FORMAT	
DATA BITS	7 serial, asynchronous
DATA BIT 8	1, 0 or deleted
PARITY	Odd, even or deleted with error displayed as DLE
STOP BITS	1 or 2
DATA TRANSFER RATE	50, 75, 110, 134.5, 150, 300, 600, 1200, 1800, 2000, 2400, 3600, 4800, 7200, 9600 BAUD

STANDARD FEATURES

INVERSE VIDEO	Operator or software selectable
TRANSMIT MODES	Half or full duplex (switch selectable)
DATA ENTRY	Top or bottom line
END OF LINE BELL	Switch selectable
CURSOR POSITIONING	X–Y
CURSOR ADDRESS	Load and read
DISPLAYABLE CHARACTERS	126 (including space)
CURSOR CONTROLS	Up, down, left, right, home, return
AUTOMATIC ROLL-UP	Switch selectable
AUTO CARRIAGE RETURN AND LINE FEED	Switch selectable
MONITOR MODE	Special "Monitor" Mode allows display of control codes (first two columns) of ASCII Code Chart).

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Your turn: Show the Scan PROM truth table and switch settings for an H8 Scan of 40 repacked characters per line.

Front Panel Interaction

The H8 front panel works by interrupting a running program once every two milliseconds. If we try to run scan software and the front panel at the same time, the display will be badly torn up. So, we can either turn the front panel off during display times or else combine the front panel and the video scan into a single program. Just turning the front panel off is far simpler and usually all you will need to do.

The H8 front panel monitor does have a "turn the display off" software word. But this won't help us. While this command shortens the interrupt and keeps it from lighting the display, the interrupt still exists.

One hardware solution is shown in Fig. 11. A new switch is added to the front panel that prevents timer-generated level 10 interrupts from happening. This, in turn, keeps the panel display off and the video display in one piece. This switch will be very handy during your initial test and debugging of video displays. You should only turn *off* the front panel after you have a video display, and turn it back *on* before returning to other uses. The RST/0 command does bypass this switch so that you can reset under any conditions.

This switch will most likely *not* be needed when your properly designed and debugged scan software is operational. You probably can eliminate it from the final use circuitry.

The obvious question is how to use software instead. We have a good old DI, or "disable interrupts," command in the 8080 instruction set. Can't we simply use this?

Unfortunately, there is one very noisy gotcha that may keep you from doing this—unless you are careful.

If you try an immediate DI command in an H8 program, the speaker will latch on and *stay* on. That little beep you get when you hit the GO key—or any other key—needs *two* more interrupts *after* your program starts. No interrupts, no stopping. The two interrupts time out a four millisecond tic for the horn circuit.

The H8 front panel monitor needs a few milliseconds *after* it is exited before you can disable any interrupts. If you disable an interrupt too soon you will lock the speaker on.

You can use the DI command to turn off the front panel, but you must delay at least five milliseconds *after* your program starts or the speaker won't quit. Thus, one properly placed software word is all you need to get full front panel and video display compatibility.

Test Software

Two useful test routines are shown in Fig. 12. Fig. 12a checks Scan PROM access and operation. If this test fails, you are either incorrectly picking up scan microinstructions or are missing them entirely. Erratic switching between 311 (return) and 000 (no operation) means you have speed-doubling problems. All 000s means you are never activating the Scan PROM, while all 311s means you are permanently trying to return from a Scan Microinstruction call. This particular test works with either HS64 or HS80 Scan PROMs and can have the address switches in any position.

Your turn: Why?

Don't ever try going beyond this test if the test fails. If you cannot read the proper return from a scan microinstruction, it will not execute, and anything else you add in the way of software or time or effort will only compound the felony.

Test sequence Fig. 12b lets you transfer control of the H8 from computer to TVT scanning and back again. Note that the test coding differs for each Scan PROM and that each Scan PROM has to have the address switches set as shown.

The scanning process is adjusted to output a TV horizontal scan at normal scan frequencies. In a completely working system with a disabled front panel, you'll get a continuous series of vertical stripes. This corresponds to the seventh dot row of a random character load. A wildly wrong horizontal scan frequency usually means the wrong switch settings or the wrong Scan PROM. Vertical stripes that have teeth in them may be caused by erratic data latching or improper speed-doubling operation.

While these two tests appear trivially simple, don't overlook them as major debugging aids. If these two won't go, no other software will run either.

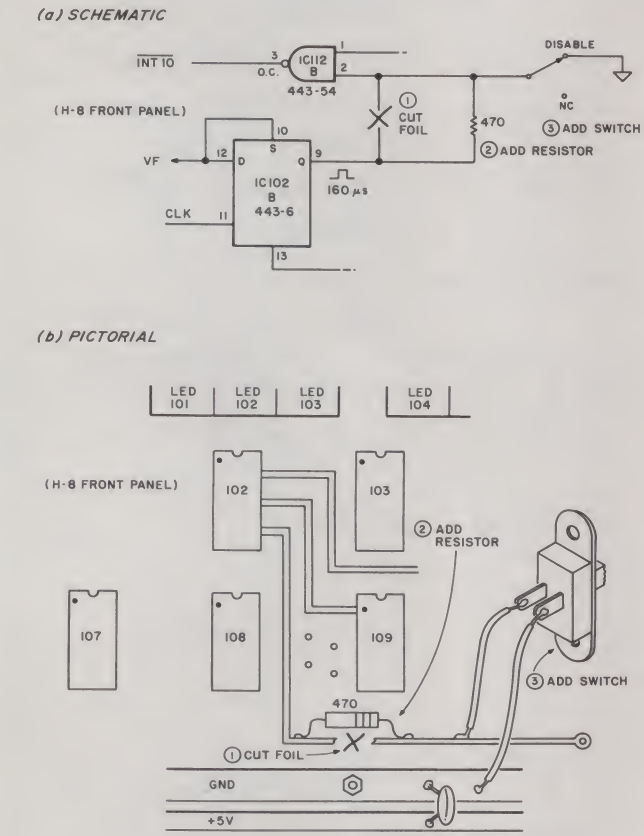


Fig. 11. A switch to temporarily defeat the H8 front panel display will be useful for TVT debugging and checkout.

A. To verify that the Scan Microinstruction is alive and well:

read

```
300 376   for   000   (NOP)
300 377   for   311   (RET)
301 000   for   000   (NOP)
```

Either the HS64 or the HS80 Scan PROM may be used.
The address switches may be in any position.

B. To pass control to and from the Scan Microinstruction at a TV Horizontal rate:

For Scan PROM HS64

Set switches to "32"; A5 = "+" and A4 = "A4"

```
START→040 100   CALL   315 010 320   Scan seventh dot row
      040 103   JMP    303 100 040   Repeat
```

For Scan PROM HS80

Set switches to "64"; A5 = "A5" and A4 = "A4"

```
START→040 100   CALL   315 030 320   Scan seventh dot row
      040 103   JMP    303 100 040   Repeat
```

This will display continuous vertical stripes that correspond to the *seventh* dot row of a random character load. The front panel should be switch disabled during viewing times.

H8 Scan time is 63 microseconds for a horizontal scan frequency of 15.898 kHz. There is no vertical sync.

Fig. 12. Two test routines useful in 8080/TVT debugging.

Self-Modifying vs Brute Force Scans

The obvious next thing to do is take the old 6502 scan software programs and literally translate them, replacing a CALL for a JSR and so on. But we really get into trouble in a hurry if we try this. First, some commands will be longer or shorter than their 6502 counterparts, messing up the critical horizontal-edge-to-horizontal-edge timing. Worse yet, the execution time of an 8080 working with literally translated 6502 commands is pitifully slow—so slow that the critical timing loop may take over 30 microseconds, compared to the 21 used in the 6502. This makes the long horizontal lines so long we don't want to even think about using them.

One solution is to make the 8080 into an 8080 rather than an imitation 6502. You can do this using the fast register-to-register transfer commands and get your loop times down only slightly longer than those in the 6502 programs.

But is this really what we want in an 8080 system? Remember that on a bare-bones KIM-1 our back was to the wall in finding room for a scan program. We *had* to get by with the absolute minimum-length scan programs *in* order to get any video at all.

One result of this restriction was that our scan code was *self-modifying*. This meant that the scan program computed its next set of memory locations rather than looking them up. This, in turn, meant that the scan program *had* to be in RAM during final operation, at least on a KIM.

Usually our 8080 systems have enough RAM and PROM available that we needn't worry too much about minimizing code. So, why not use *brute force* coding that calls each scan address as it is needed? We can store the whole scan program in ROM or PROM this way and never have to load it again . . . or worry about it bombing when something bad happens in RAM.

Brute force coding will also be much faster. It will be much easier to write, modify and debug. But, as usual, there is a price. Brute force coding can be much longer than self-modifying coding. On a one-line display, this turns out to be a no-hassle 43 words versus the 30 words we needed on a KIM with self-modifying code. But on a long and involved program such as a 24 × 80 double-stuffed scan, it could take 600 or more words of code to get us by. Still, that's only little over half a 2708 or slightly over a quarter of a 2716 EPROM and no real big deal these days.

Let's use this brute force approach to generate a simple one line display and then apply it to a 12 × 80 scan program.

1 × 56 Scan Program

Fig. 13 shows a brute force scan program for a one line, 56 character no-interlace 8080/TVT 6-5/8 display. Each successive dot row is called by a scan subroutine as it is needed. We start in 040 100 with a short blank scan to get us off on the right foot. Then we sequentially call dot rows 1 through 7 of the characters to be displayed. This live scanning is followed by a vertical sync pulse.

After this, a word that sets the number of blank scans is loaded in the accumulator (365). As many blank scans as needed are generated in turn. Each time a blank scan is completed, the accumulator word is decremented till the word hits zero. At that time, the program jumps to the top line blank scan and repeats for the next field.

Unlike a 6502, an 8080 can take an even or an odd number of *half* microseconds to complete an instruction. In most scan programs, some equalization will be needed to make up for this half-microsecond jitter. The command MOVAA, or "move the accumulator to itself," takes 2.5 microseconds and is a benign instruction. This lets us shift timing by half a microsecond if used once and by one microsecond if used

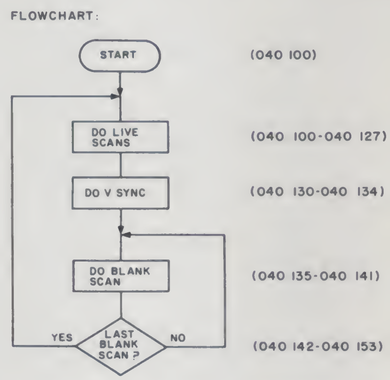


Fig. 13a. Program flowchart.

```
uP-8080A      Start-JMP 040 100        Displayed       340 004 to 340 037
System-H8     End-RST/0                                342 004 to 342 037
                                       Program Space   040 100 to 040 152
                                                       (43 words)

START ---> 040 100   CALL  315  017  140      Do short blank scan
           040 103   CALL  315  004  160      Scan Dot row #1
           040 106   CALL  315  004  200      Scan Dot row #2
           040 111   CALL  315  004  220      Scan Dot row #3

           040 114   CALL  315  004  240      Scan Dot row #4
           040 117   CALL  315  004  260      Scan Dot row #5
           040 122   CALL  315  004  300      Scan Dot row #6
           040 125   CALL  315  004  320      Scan Dot row #7

           040 130   LDA   072  000  340      Output Vertical sync pulse
           040 133   MVIA  076  365           Load # of blank scans
         ->040 135   CALL  315  011  140      Do blank scan
           040 140   DCRA  075                One less scan

           040 141   MOVAA 177                Equalize 2.5 microseconds
          -040 142   JNZ   302  (135)(040)    One more blank scan?
           040 145   MOVAA 177                Equalize 5.0 microseconds
           040 146   MOVAA 177                    continued

           040 147   DI    363                Shut off horn
          -040 150   JMP   303 (100)(040)     Go to live scans
```

Mods:

To relocate display space, use program jumpers on memory card or else change starting address of dot scans.

To put both halves of display space closer together, use A4 switching rather than A9 switching.

For double height characters, repeat scan of each dot row twice.

Notes:

- TVT 6-5/8 must be connected via an 8080 adapter, and both the 658-HD8 and 658-HS64 PROMs must be in circuit for the program to run.
- Horizontal frequency 15.174 kHz; Vertical frequency 59.976 Hz. 2500 second hum bar.
- Address switches must be in "32", A5 = " + ", and A4 = "A4" positions.
- Character sequence goes 340 004; 342 004; 340 005; 342 005; 340 006; 342 006; 340 007. . . . .
- ( ) denotes an absolute address that is program location sensitive.
- This program is not self-modifying and may be placed in PROM or ROM.

Fig. 13 Program for a one line, 56-character, no-interlace TVT 6-5/8 8080 raster scan.

Fig. 14. Program for a 12 line, 80-character-per-line, full-interlace, double-stuffed TVT 6-5/8 raster scan.

```
                 uP-8080A         Start-RUN 040 100
                 System-H8        End-RST/0
                     Displayed    340 010 to 343 377
                 Program Space    040 100 to 042 007 (455 words)

                        (even field)
START----->040 100  CALL  315  023  140     Do short blank scan

           040 103  CALL  315  010  140     Scan dot row 0, character line 1
           040 106  CALL  315  010  200               "      2        "       1
           040 111  CALL  315  010  240               "      4        "       1
           040 114  CALL  315  010  300               "      6        "       1
           040 117  CALL  315  010  140     Do blank scan

           040 122  CALL  315  060  140     Scan dot row 0, character line 2
           040 125  CALL  315  060  200               "      2        "       2
           040 130  CALL  315  060  240               "      4        "       2
           040 133  CALL  315  060  300               "      6        "       2
           040 136  CALL  315  060  140     Do blank scan

           040 141  CALL  315  130  140     Scan dot row 0, character line 3
           040 144  CALL  315  130  200               "      2        "       3
           040 147  CALL  315  130  240               "      4        "       3
           040 152  CALL  315  130  300               "      6        "       3
           040 155  CALL  315  130  140     Do blank scan

           040 160  CALL  315  210  140     Scan dot row 0, character line 4
           040 163  CALL  315  210  200               "      2        "       4
           040 166  CALL  315  210  240               "      4        "       4
           040 171  CALL  315  210  300               "      6        "       4
           040 174  CALL  315  210  140     Do blank scan

           040 177  CALL  315  260  140     Scan dot row 0, character line 5
           040 202  CALL  315  260  200               "      2        "       5
           040 205  CALL  315  260  240               "      4        "       5
           040 210  CALL  315  260  300               "      6        "       5
           040 213  CALL  315  260  140     Do blank scan

           040 216  CALL  315  330  140     Scan dot row 0, character line 6
           040 221  CALL  315  330  200               "      2        "       6
           040 224  CALL  315  330  240               "      4        "       6
           040 227  CALL  315  330  300               "      6        "       6
           040 232  CALL  315  330  140     Do blank scan

           040 235  CALL  315  010  141     Scan dot row 0, character line 7
           040 240  CALL  315  010  201               "      2        "       7
           040 243  CALL  315  010  241               "      4        "       7
           040 246  CALL  315  010  301               "      6        "       7
           040 251  CALL  315  010  141     Do blank scan
           040 254  CALL  315  060  141     Scan dot row 0, character line 8
           040 257  CALL  315  060  201               "      2        "       8
           040 262  CALL  315  060  241               "      4        "       8
           040 265  CALL  315  060  301               "      6        "       8
           040 270  CALL  315  060  141     Do blank scan

           040 273  CALL  315  130  141     Scan dot row 0, character line 9
           040 276  CALL  315  130  201               "      2        "       9
           040 301  CALL  315  130  241               "      4        "       9
           040 304  CALL  315  130  301               "      6        "       9
           040 307  CALL  315  130  141     Do blank scan

           040 312  CALL  315  210  141     Scan dot row 0, character line 10
           040 315  CALL  315  210  201               "      2        "       10
           040 320  CALL  315  210  241               "      4        "       10
           040 323  CALL  315  210  301               "      6        "       10
           040 326  CALL  315  210  141     Do blank scan

           040 331  CALL  315  260  141     Scan dot row 0, character line 11
           040 334  CALL  315  260  201               "      2        "       11
           040 337  CALL  315  260  241               "      4        "       11
           040 342  CALL  315  260  301               "      6        "       11
           040 345  CALL  315  260  141     Do blank scan

           040 350  CALL  315  330  141     Scan dot row 0, character line 12
           040 353  CALL  315  330  201               "      2        "       12
           040 356  CALL  315  330  241               "      4        "       12
           040 361  CALL  315  330  301               "      6        "       12
           040 364  CALL  315  330  141     Do blank scan

           040 367  MVIA  076  006          Delay 48.5 microseconds
           040 371  DCRA  075                     continued
           040 372  JNZ   302 (371)(040)          continued

           040 375  LDA   072  000  340     Output //VERTICAL SYNC// pulse
           041 000  CALL  315  363  140     Do short blank scan
           041 003  LDA   072  000  000     Delay 6.5 microseconds
           041 006  MVIA  076  175          Load # of vertical blank scans

        -->041 010  CALL  315  015  140     Do //BLANK VERTICAL SCANS//
           041 013  DCRA  075               One less blank scan
           041 014  MOVAA 177               Equalize 2.5 microseconds
        ---041 015  JNZ   302 (010)(041)    Repeat blank scans if not done

           041 020  MOVAA 177               Equalize 5 microseconds
           041 021  MOVAA 177                     continued
           041 022  DI    363               Shut off horn
```

twice. This is the purpose of those strange "177" instructions in the program.

In step 040 147, we disable the interrupts. This turns off our front panel but does so late enough that we will not lock the speaker on. Since the code is not self-modifying, you can put it in your choice of RAM, ROM, PROM, EPROM or E²PROM. Naturally, you'll want to check things out in RAM first before committing yourself to permanent code.

Your turn: Show the coding needed for 1×32, 1×64 and 1×80 scans.

As a hint that will save you lots of trial and error or calculations, keep your blank initial scan *nine* counts short of the live scans and keep the retrace blank scans *five* counts short of your live scans. A stationary or near-stationary hum bar is picked up by adjusting *040 134* as needed. A more obvious route to shorter scans is to simply use the 1×56 and load blanks as needed in unused character locations.

TV Retrace Hassles

Calling and returning from a subroutine takes around 13.5 microseconds on a typical 8080. Two of these microseconds are spent on the live scan, leaving us with a retrace time of 11.5 microseconds. Since the H8 is slightly faster than this, our available retrace time is around 11.2 microseconds.

Naturally, we would like to keep our retrace times as short as possible. This lets you put more characters on the line for standard horizontal rates or lets you run long character lines with more nearly normal horizontal frequencies.

But 11 microseconds may not be enough time for your monitor or TV set to cleanly get from the end of one line to the beginning of the next. For most monitors and some TV sets, 11 microseconds will be just barely enough.

If you are having trouble displaying all the characters, here are some hints that may help you:

- Your simplest out is to adjust

the display centering so that the first character is always legible. Always stop short of the maximum display length on your statements.

- Use the *maximum* possible width. Raising the width coil inductance (see *Cheap Video Cookbook*, Fig. 3-33) can lengthen the needed retrace time.
- Use a longer-than-needed character line and put permanent blanks where they are called for.
- Add equalization to lengthen each CALL sequence. While this is the obvious and cleanest route, it can add many words to a brute force scan program.
- If you *thoroughly* understand TV horizontal scanning *and* have a decent scope *and* full TV documentation, modify the flyback capacitor value as needed to get a faster retrace. But, be careful to not exceed the peak allowable horizontal output transistor voltage when you do this.

More Characters

Our 1 × 56 scan has several obvious limitations. From this starting point, we'll want to add interlace, double stuffing and lots more characters.

The optimum number of characters or chunks per line seems to be 56 for an H8 system using A9 switching for speed doubling. This 56-character length lets you use a standard horizontal frequency. You can display on either a color or a black and white set.

But there seems to be something magical about 80 character lines that appeals to people, even though this many characters are hard to read and are rarely, if ever, needed. So, to prove it can be done, we're going to show you how to display 80 character lines on your H8 and then put those lines on a TV with unmodified video bandwidth or over an rf modulator. Remember, though, that we'll have to run at a reduced horizontal rate, which will take width and hold modifications to your small-screen, transformer-operated, *Photofact*-available, black and white set. Furthermore, your wrong choice

```
041 023   JMP    303 (100)(041)    Jump to odd field
(041 026 to 041 077 are spares)
                    (odd field)
041 100   CALL   315  023  140     Do short blank scan

041 103   CALL   315  010  160     Scan dot row 1, character line 1
041 106   CALL   315  010  220       "          3      "          1
041 111   CALL   315  010  260       "          5      "          1
041 114   CALL   315  010  320       "          7      "          1
041 117   CALL   315  010  140     Do blank scan

041 122   CALL   315  060  160     Scan dot row 1, character line 2
041 125   CALL   315  060  220       "          3      "          2
041 130   CALL   315  060  260       "          5      "          2
041 133   CALL   315  060  320       "          7      "          2
041 136   CALL   315  060  140     Do blank scan

041 141   CALL   315  130  160     Scan dot row 1, character line 3
041 144   CALL   315  130  220       "          3      "          3
041 147   CALL   315  130  260       "          5      "          3
041 152   CALL   315  130  320       "          7      "          3
041 155   CALL   315  130  140     Do blank scan

041 160   CALL   315  210  160     Scan dot row 1, character line 4
041 163   CALL   315  210  220       "          3      "          4
041 166   CALL   315  210  260       "          5      "          4
041 171   CALL   315  210  320       "          7      "          4
041 174   CALL   315  210  140     Do blank scan

041 177   CALL   315  260  160     Scan dot row 1, character line 5
041 202   CALL   315  260  220       "          3      "          5
041 205   CALL   315  260  260       "          5      "          5
041 210   CALL   315  260  320       "          7      "          5
041 213   CALL   315  260  140     Do blank scan

041 216   CALL   315  330  160     Scan dot row 1, character line 6
041 221   CALL   315  330  220       "          3      "          6
041 224   CALL   315  330  260       "          5      "          6
041 227   CALL   315  330  320       "          7      "          6
041 232   CALL   315  330  140     Do blank scan

041 235   CALL   315  010  161     Scan dot row 1, character line 7
041 240   CALL   315  010  221       "          3      "          7
041 243   CALL   315  010  261       "          5      "          7
041 246   CALL   315  010  321       "          7      "          7
041 251   CALL   315  010  141     Do blank scan

041 254   CALL   315  060  161     Scan dot row 1, character line 8
041 257   CALL   315  060  221       "          3      "          8
041 262   CALL   315  060  261       "          5      "          8
041 265   CALL   315  060  321       "          7      "          8
041 270   CALL   315  060  141     Do blank scan
041 273   CALL   315  130  161     Scan dot row 1, character line 9
041 276   CALL   315  130  221       "          3      "          9
041 301   CALL   315  130  261       "          5      "          9
041 304   CALL   315  130  321       "          7      "          9
041 307   CALL   315  130  141     Do blank scan

041 312   CALL   315  210  161     Scan dot row 1, character line 10
041 315   CALL   315  210  221       "          3      "          10
041 320   CALL   315  210  261       "          5      "          10
041 323   CALL   315  210  321       "          7      "          10
041 326   CALL   315  210  141     Do blank scan

041 331   CALL   315  260  161     Scan dot row 1, character line 11
041 334   CALL   315  260  221       "          3      "          11
041 337   CALL   315  260  261       "          5      "          11
041 342   CALL   315  260  321       "          7      "          11
041 345   CALL   315  260  141     Do blank scan

041 350   CALL   315  330  161     Scan dot row 1, character line 12
041 353   CALL   315  330  221       "          3      "          12
041 356   CALL   315  330  261       "          5      "          12
041 361   CALL   315  330  321       "          7      "          12
041 364   CALL   315  330  141     Do blank scan

041 367   LDA    072  000  340     Output //VERTICAL SYNC// pulse
041 372   MVIA   076  175          Load # of vertical blank scans

041 374   CALL   315  015  140     Do  //BLANK VERTICAL SCANS//
041 377   DCRA   075               One less blank scan
042 000   MOVAA  177               Equalize 2.5 microseconds
042 001   JNZ    302 (374)(041)    Repeat blank scans if not done

042 004   MOVAA  177               Equalize 5 microseconds
042 005   MOVAA  177                  continued
042 006   DI     363               Shut off horn
042 007   JMP    303 (100)(040)
```

Notes:

- TVT 6-5/8 must be connected via an 8080 adapter, and both the 658-HD8 and 658-HS80 PROMs must be in circuit for the program to run.
- Address switches must be in "64"; A5 = "A5"; and A4 = "A4" positions.
- Horizontal frequency = 11.191 kHz Vertical frequency = 60.006 Hertz. 166 second hum bar.
- This program is not self-modifying and may be placed in PROM or ROM.
- Character sequences goes 340 000; 350 000; 340 001; 350 001; 340 002; 350 002; 340 003 . . . . . .

() denotes an absolute address that is program location sensitive.

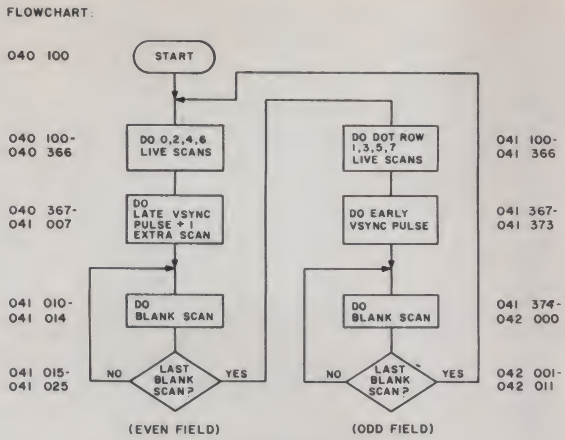


Fig. 14a. Program flowchart.

of set could sing objectionably.

12 Lines of 80 Characters

A brute force, interlaced, double-stuffed 12 × 80 scan program appears in Fig. 14. You can easily modify it for 24 × 80 or even 36 × 80 displays if you like. With the double stuffing, the 12 × 80 display uses slightly less than one-third of the H8 throughput time. By going to suitable transparency techniques, you can save two-thirds of the computer time to transparently run other programs such as Extended BASIC.

We've shown you this scan program with its memory space at 340 010 to 343 377. This assumes you have at least two RAM cards in your H8 and have put this particular one "out on top" with the "56K" jumper on the memory card. You may want to relocate things later, but this is a handy place to start.

The TVT 6-5/8 is attached to the memory card by way of an 8080 adapter similar to Figs. 4 and 10. The TVT does place certain use restrictions on the 340 000 to 360 000 computer address space, since any activity here also gives you a vertical sync pulse that might disrupt an enabled display. You *can* use this space for a display memory RAM; you should *not* use this area for the scan program or the computer stack. If you do use this page for display memory RAM, you will have to watch your cursor program carefully if transparent character entry is important to you.

You'll find the 12 × 80 program shown in two separate fields. We have an *even* field that puts down the even dot rows of all the characters and an *odd* field that puts down the odd dot rows of all the characters. When combined, these fields form an interlaced and double-stuffed frame. Having the two fields separate is handy for debugging. By jumping a field back on itself, you can display all-even or all-odd fields to fix coding errors or make format changes.

The scan program runs just about the same way the earlier 1 × 56 program did. First, there is a short blank scan; then we put down the even dot rows of all the characters. Then we equalize, followed by a *late* vertical sync pulse, at the same time taking up one entire *extra* horizontal scan time. Then we run the usual blank vertical scans, completing the field.

When the field is finished, we jump to the odd field, run a short blank scan and put down all the odd dot rows of all the characters. After this, we run an *early* vertical sync pulse and go on to the usual number of vertical blank scans. The scan sequence repeats by jumping to the start of an even field.

The early and late vertical sync pulses differ by half a horizontal line. When you combine this half a line with the *extra* horizontal line picked up only in the even scan, you end up with an interlaced scan of 373 whole lines taking one 30 Hz frame. This 30 Hz frame consists of two 60 Hz fields of 186.5 lines each.

The 658-HS80 Scan PROM lets you repack the 80 character lines so you can use your display memory space efficiently. Fig. 15 shows how the characters are arranged in RAM. While this looks like a royal mess, a few extra cursor words are all we need to straighten things out. This is often a reasonable trade-off for letting us do long lines with an 8080 in the first place and freeing up 600 or so words of system RAM for other uses.

Your turn: Show the coding for 24 × 80, 32 × 80, 16 × 56, 32 × 56, 16 × 64 and 32 × 64 scan programs. Show ways of significantly shortening the 12 × 80 scan program while staying PROM compatible. Try: (1) using only one vertical blanking sequence and minimizing blank sequences and unused code words; (2) using I/O commands to free address space; (3) using interrupt rather than subroutine mapping.

Note that you'll use the HS64 PROM for 64 and shorter character lines and most graphics, while the HS80 PROM is usually reserved for 80 character lines. You can do 40 character lines with the HS64 without repacking, or else you can use your memory more efficiently by going to a specially coded HS40 PROM that uses repacking. Repacking saves you RAM space but needs a few extra words in the cursor program and takes a special Scan

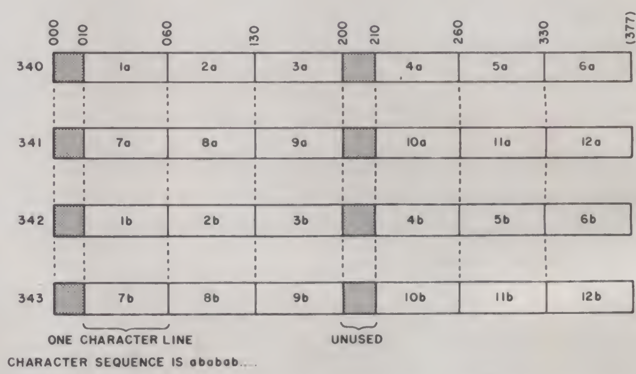


Fig. 15. Display memory map for 12 × 80 scan.

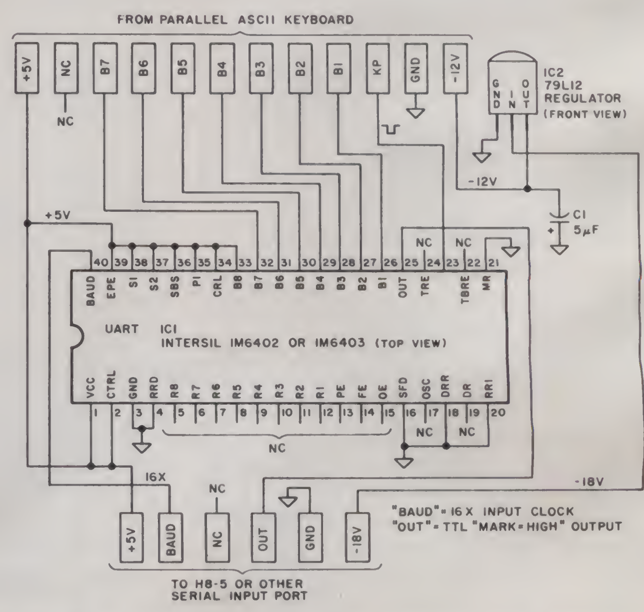


Fig. 16. This keyboard serial adapter lets you connect a keyboard to a serial computer input.

PROM.

A Keyboard Serial Adapter

If you have an H8-2 parallel interface card, it should be fairly easy to interface almost any old ASCII keyboard and encoder. You could do this essentially the same way we did it on the parallel KIM inputs back in the *Cheap Video Cookbook*, but the H8-2 card is an expensive option and you might not already have one on hand. More likely, you'll be using the H8-5 serial interface card instead, since you need this one for the usual cassette and remote terminal uses.

Most ASCII keyboards and encoders provide only a parallel (all-the-bits-at-once) output. To enter a serial port, we have to convert this parallel word into a serial (one-bit-at-a-time) sequence. A simple adapter to do this is shown in Fig. 16.

The circuit can use the transmitter half of nearly any old UART (universal asynchronous receiver-transmitter). We first looked at UARTs back in Chapter 7 of the *TVT Cookbook*. You'll find this circuit easier and more inexpensive when you use a modern, single-supply CMOS chip such as an *Intersil* iM6402 or IM6403.

The keyboard serial adapter works by borrowing power from the H8-5 serial interface and feeding +5 volts and optionally −12 volts to your existing keyboard. Your existing keyboard outputs are most likely available in *parallel* or "all-at-once" form. These parallel outputs and a normally-high keypressed *strobe* are routed to the transmitter side of the UART in the adapter. This UART also borrows a 16X baud clock from the H8-5.

When you press a key, a serial output is generated by the UART. This serial output is then routed to your computer's serial interface and received just as if it came from a terminal.

You may need as many as five leads between your adapter and the H8-5. One is ground, two are for power, one is the 16X baud rate clock that goes *to* the adapter and the final is the serial output that comes *from* the adapter. Fig. 17 shows you how to connect, both pictorially and schematically, your adapter to your H8-5. You can either hard-wire these connections or add a new connector of your own.

On your H8-5 board, integrated circuit IC122 is removed and replaced with two jumpers inserted in the socket as shown. The pin-11-to-pin-13 jumper gives you direct access to the serial input on the UART present inside the H8-5. The pin-6-to-pin-7 jumper lets you use the keyboard in a *polled* mode. This polled operation gives you a transparent scan program and frees the interrupts for other uses.

The H8 has to be software-programmed to use your new adapter. A simple test sequence that will enter the last-pressed key into the accumulator and display it for you is shown in Fig. 18.

The H8-5 is first initialized with a *mode* instruction. You can use 312 and output it to port 373. This picks two stop bits, ignores parity, uses a seven-bit word and runs with a 16X clock. Next, you continue to initialize the H8-5 by giving a *command* instruction to the same port. This time, use 004 and once again output it to port 373. This command instruction will enable only the receiver in the H8-5 interface.

After the mode instruction and the command instruction are routed to the interface, you are free to read characters. You do this by inputting from port 372. The final loop in the test program does this continuously.

As you press a key, its ASCII value will appear in the left three digits of the "AF" Register display. For instance, a lowercase "b" will read 142, while an uppercase "B" will read 102.

There are a few gotchas in this simple test program, so you'll want to improve it for actual use as part of a cursor. Note that this simple program continuously *rereads* characters instead of reading each one just once. To beat this, there is available a "character ready" (R × RDY) flag that is set when

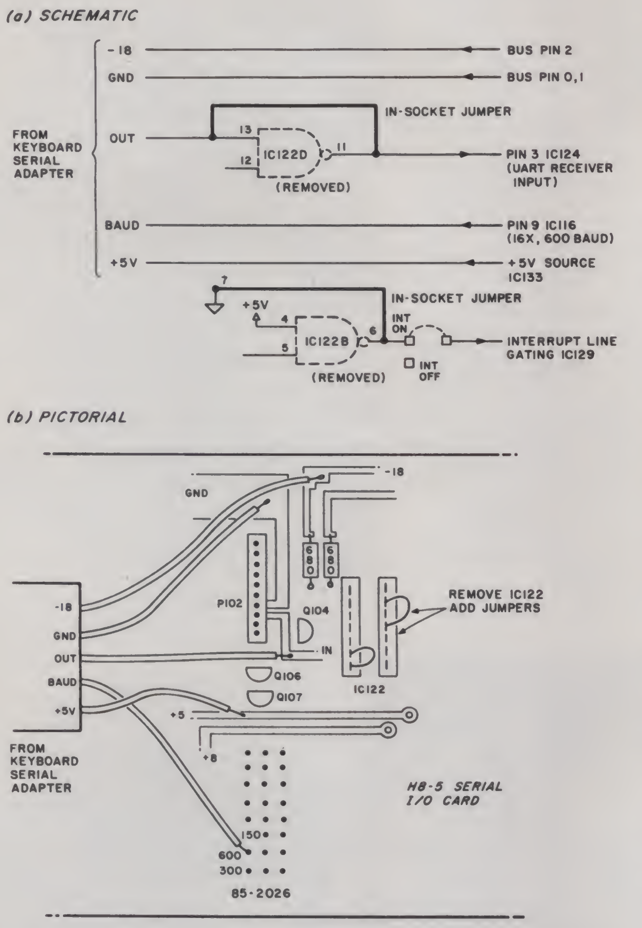


Fig. 17. Connecting your keyboard serial adapter to an H8-5 interface.

```
                      uP-8080A          Start-JMP 040 100
                      System-H8 + H8/5  End-RST/0
                      Program Space     040 100 to 040 113 (13 words)

(START)-> 040 100   MVIA   076  312           Initialize mode instruction
          040 102   OUT    323  373                continued
          040 104   MVIA   076  004           Initialize command instruction
          040 106   OUT    323  373                continued

       -> 040 110   IN     333  372           Read Keyboard
          040 112   JMP    303  (110)(040)    Loop
```

Notes:

- This test program displays a pressed key received via the Keyboard Serial Adapter. To run the program, use:
RST/0-REG-PC-ALTER-0-4-0-1-0-0-ALTER-REG-AF-GO.
- ASCII characters should appear as the three leftmost digits on the display. For instance, "A" = 101, "a" = 141, "6" = 066, and "CR" = 015.
- ( ) Denotes an absolute address that is relocation sensitive.

Fig. 18. Keyboard serial adapter test program.

the character first arrives and is reset as soon as the computer uses the character for the first time.

To use a character only once, input from port 373, AND what you get with 002 and test the result. A nonzero result means you have a new character ready to enter. A zero result says you have already used the character on-hand and should ignore it. We'll see an example on this shortly.

The UART doing the transmitting (in the adapter) and the one doing the receiving (in the H8-5) must agree on the baud rate and the baud clock factor. Usually, the H8-5 will be set on 600 baud and 16X clocks with internal jumpers. If not, or if you are on a different system, be sure that the transmitting UART and the receiving UART are on speaking terms with each other.

Note that your initialization of the *mode* and *command* words should be done only once after reset and before any input/output activity. If you don't initialize, you'll get no characters at all, and if you continuously re-initialize, characters will get dumped before you can use them.

Your keyboard serial adapter is very flexible. For instance, go over the data sheets to find a whole unused UART receiver on the low number pins. The −12 volt supply is an option. You can eliminate it if you already have −12 on hand or use a keyboard that doesn't need it. You can also use the old-style UARTs that need −12 by removing the connections on pin #2 and jumpering to −12.

Should you use the IM6403, you can eliminate the 16X baud rate line by connecting a 3.58 MHz color TV crystal between pins 17 and 40 while grounding pin 3 of the IM6403. This will output characters for you at 110 baud. Your computer's serial input will also have to be jumpered or programmed to use this new data rate.

As shown, the keyboard serial adapter is programmed to provide a permanent one in the transmitted ASCII bit #8, is continuously enabled, has no parity, uses two stop bits and has an eight-bit word length. You can change any or all of these by reprogramming the hard-foil connections of pins 33 through 39 of the UART. Our circuit assumes the keyboard outputs positive logic and uses a narrow goes-to-ground-from-positive-high strobe that is low only when data is valid. The output is a simple TTL logic level. There is no need to convert to RS-232 or Teletype current loops for a short interface connection.

Your turn: Show how to use your keyboard serial adapter with only two wires between computer and keyboard, including all power supply connections. Hint: Use the IM6403 with a crystal and a CMOS-encoded keyboard. Change the current when you want to send a zero and sense this current at the computer end.

If you really want to get fancy, use ultrasonic or infrared transducers to give you zero connections between keyboard and computer. This will, of course, take batteries inside the keyboard, or will it?

8080 Cursor Software

Many of the ideas we have already used for our previous cur-

Fig. 19. Program for a one-line, 56-character TVT 6-5/8 8080 raster scan integrated minimum cursor.

```
uP-8080A     Start-JMP 040 100        Displayed        340 004 to 340 037
System-H8    End-RST/0                                 342 004 to 342 037
                                       Program Space    040 100 to 040 341
                                       Registers Used   -B,     H,      L

Main scan sequence:

(START)-->040 100   MVIA  076  312          Initialize MODE for H8-3
          040 102   OUT   323  373                 continued
          040 104   MVIA  076  004          Initialize COMMAND for H8-3
          040 106   OUT   323  373                 continued

          040 110   CALL  315  017  140     Do short BLANK SCAN
          040 113   CALL  315  004  160     Scan Dot row #1
          040 116   CALL  315  004  200     Scan Dot row #2
          040 121   CALL  315  004  220     Scan Dot row #3

          040 124   CALL  315  004  240     Scan Dot row #4
          040 127   CALL  315  004  260     Scan Dot row #5
          040 132   CALL  315  004  300     Scan Dot row #6
          040 135   CALL  315  004  320     Scan Dot row #7

          040 140   MVIB  006  364          Load number of blank scans in B
          040 142   IN    333  373          Is a new key pressed?
          040 144   ANI   346  002          Mask kepressed bit
          040 146   JZ    312 (154)(040)    No, continue scan

(040 220)<--040 151 CALL  315 (220)(040)    Yes, go to cursor
          040 154   CALL  315  015  140     Do equalizing BLANK SCAN
          040 157   LDA   072  000  340     Output vertical sync pulse
          040 162   MOVBA 170  170          Get number of blank scans back

          040 164   CALL  315  011  140     Do BLANK SCAN
          040 167   DCRA  075               One less scan
          040 170   MOVAA 177               Equalize 2.5 microseconds
          040 171   JNZ   302 (164)(040)    Do another blank scan?
          040 174   MOVAA 177  177          Equalize 5 microseconds

          040 176   DI    363               Shut Off Horn
          040 177   JMP   303 (110)(040)    Go to new field

  CURSOR
  RETURN

Cursor Processing Subroutine:

(040 151)-->040 220 MOVAH 174               Get upper cursor address
 (Enter)    040 221 ANI   346  375          Mask A9 out
            040 223 CPI   376  340          Is upper page address valid?
            040 225 JZ    312 (233)(040)    Yes, OK to continue
(040 260)<--040 230 CALL  315 (260)(040)    No, clear screen via subroutine
            040 233 MOVAL 175               Get lower cursor address
            040 234 ANI   346  037          Put it on the screen
            040 236 MOVLA 157               Replace lower cursor

            040 237 IN    333  372          Get character
            040 241 CPI   376  015          Is it Carriage Return (Erase)?
            040 243 JZ    312 (260)(040)    Yes, clear screen via subroutine
(040 300)<--040 246 CALL  315 (300)(040)    No, enter character via subroutine

            040 251 RET   311               Return to scan program

        (040 251 through 040 257 are spares; not used)

(040 320)<--040 260 CALL  315 (320)(040)    go to clear screen subroutine
            040 263 MVIB  006  331          Equalize # of blank scans remaining
(040 154)<--040 265 RET   311               Return to Processing
 (Exit)
```

Enter Character and Increment Subroutine:

```
(enter)  ──► 040 300   MOVMA 167                   Store character at cursed location
             040 301   MOVAH 174                   Get upper cursor word
             040 302   XRI   356  002              Change address A9
             040 304   MOVHA 147                   Replace upper cursor word

             040 305   ANI   346  002              Is address A9 now zero?
(exit 1) ◄── 040 307   RNZ   300                   No, return
             040 310   INXH  043                   Yes, increment HL (cursor address)
(exit 2) ◄── 040 311   RET   311                   Return to Processing

(Enter)  ──► 040 320   LXIH  041 (004)(340)        Home Cursor
          ┌► 040 323   MVIA  076  040              Load Space
          │  040 325   CALL  315 (300)(040)        Enter space via ECI subroutine
          │  040 330   MVIA  076  040              Is it the end of the screen?

          │  040 332   CMPL  275                       continued...
          └─ 040 333   JNC   302 (323)(040)        No, add more spaces
             040 336   LXIH  041 (004)(340)        Yes, home cursor
(Exit)   ◄── 040 341   RET   311                   Return to Processing
```

Notes:

- TVT 6-5/8 must be connected via an 8080 adapter and both the 658-HD8 and 658-HS64 PROMs must be in circuit for the program to run. Character entry via keyboard, a keyboard serial adapter and the H8-3 serial interface card.
- All characters and all control commands are entered on the screen, except for carriage return (CR), which clears the screen.
- Horizontal frequency is 15.174 kHz; Vertical frequency is 59.976 Hz. 2500 second hum bar.
- Address switches must be in "32"; A5 = " + "; and A4 = "A4" positions.
- Character sequence goes 340 004; 342 004; 340 005; 342 005; 340 006; 342 006; 340 007. . . .
- This program is not self-modifying and may be placed in PROM or ROM. Register "B" is used for temporary storage; Registers "HL" are used to hold the cursor address.
- To aid in debugging, replace 040 147 with 000 and manually defeat front panel interrupt. To shorten number of characters displayed for a tv with limited width, use 040 337 value of 005 or higher.
- ( ) denotes an absolute address that is program location sensitive.

sors will carry over to 8080 cursor design. One new hassle we'll pick up is the straightening-out process needed to undo the A9 speed doubling. But this is more than offset by the easier and simpler code using all the available 8080 registers, particularly the 16-bit wide HL register that is ideal for cursor location storage.

Let's look at a simple cursor that ties the keyboard input to an 8080 display. We'll use the 1×56 display to keep things simple. The program and a flowchart are shown in Fig. 19.

For convenience, we've left this program in several pieces, omitted a visible cursor and done only "good enough" equalization. While you can use this program for a one-line point-of-sale terminal, as a deaf communicator or in a prompting environment, chances are that you'll want to pick up these bits and pieces and then combine them with the best of the earlier cursors to do your own thing.

Our main scan sequence is about the same as the old 1×56 scan program of Fig. 13. We've added some words at the start that initialize our H8-5 serial interface so it will accept a keyboard input by way of the keyboard serial adapter. Our brute force scans are called for next as needed to give us a line of characters.

After the characters are down, we test to see if a new key has been pressed. If not, we output a vertical sync pulse, run the blank vertical retrace scans, and then jump up and repeat everything for the next field. Note that we do *not* re-initialize the serial interface each time. We simply loop back to the start of the next field.

Now, if a key has been pressed, we jump to the new *Cursor Processing* subroutine at 040 220 through 040 251. This cursor processing subroutine first checks to make sure the HL register is holding a valid cursor location. If it isn't, the screen is erased and the cursor fixed before anything happens to other programs in the machine.

We then get a character and test it to see if it is a CR, or carriage return. If it is a CR, we erase the screen and home the cursor. CR was chosen over CAN in this example as it seems more appropriate for a one-line display. You can, of course, use any decoding you like.

If any key *but* the carriage return is pressed, the character is entered. This is done by way of an enter-character-and-increment, or ECI, subroutine. This ECI subroutine is fancier than the ones we used before, since we have the A9 switching to contend with. Some new rules and a few extra code words take care of this for us.

Remember that the A9 switching was used to let us get characters out of the 8080 fast enough to be useful. To do this, the display characters are out of order. Specifically, for our 1×56 display, the character sequence goes like this:

1st character	340 004
2nd character	342 004
3rd character	340 005
4th character	342 005
. . . . .	
55th character	340 037
56th character	342 037

Now every time we enter a character, we want to go on to the next one. So, we first *change* A9. To do this, we use an exclusive OR 002 of the H register. This will automatically make A9 a one for a particular character, a zero for the next character, a one for yet the next character and so on.

If A9 goes from a zero to a one, we need do nothing further. If A9 goes from a one to a zero, however, we need to move onto the next pair of character slots in memory. To do this, we increment the HL register that contains the cursor.

So, we change A9 *every* new character but increment our HL cursor only every *second* character. All the A9 switching mess is magically eliminated with nothing but eight or so program words.

Your turn: Show an all-the-bells-and-whistles cursor for a 24 × 80 display, including a visible cursor, full equalization and transparency, all cursor motions and the usual goodies.

As with the 6502 systems, there is virtually no limit to how fancy your cursor programs can become. All it takes are extra words of machine-language code to do almost anything you can dream up. ■

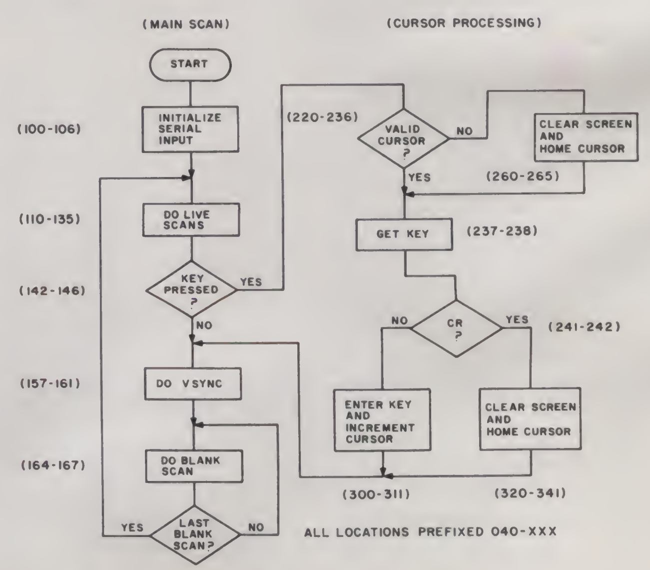


Fig. 19a. Program flowchart.

Reader Service—see page 179

Learn with Me:
Analog and Digital Interfaces

When he wrote this, Rod said: "My latest interest is digital and analog interfaces. This two-part article tells the story of my education and application of these interfaces."

Rod Hallen
Road Runner Ranch
PO Box 73
Tombstone AZ 85638

One thing you quickly discover when attempting to interface your personal computer with its surroundings is that this is an analog world we live in, and analog is a language that is foreign to a digital computer. In the digital concept everything is yes or no, on or off, black or white, while the analog world allows for an infinite number of shades of gray.

In other words, the digital computer recognizes two states, 0 (or ground or low) and 1 (or +5 V or high), while the level of an analog signal can be any value. At first the two don't seem compatible. For example, trying to use a digital serial or parallel port to directly measure the voltages in a power supply would not work. However, if you wanted to speak to someone from a foreign country and neither of you spoke the other's language, you would get an interpreter to translate.

What we need is an interpreter that will translate analog levels to digital signals and vice versa. This is the purpose of the analog-to-digital converters (ADC) and the digital-to-analog converters (DAC) that we will discuss in this two-part article. These converters can be combined to provide translation in both directions or can be used separately.

Theory—Digital-to-Analog Conversion

Fig. 1 is the schematic of a simplified digital-to-analog converter. Closing S1 will cause a current that has a value determined by the resistor in series with it to flow. Operational amplifier IC1 will convert this current flow to a voltage level. Opening S1 and closing S2 will cut the circuit resistance in half (64 Ohms instead of 128 Ohms), twice as much current will flow and the voltage out of IC1 will double.

Closing both S1 and S2 will triple the current flow as compared to S1 closed by itself, since 128 Ohms and 64 Ohms in parallel equal 42.67 Ohms, which is 1/3 of 128. In fact, the current will continue to increase in a binary fashion as more switches are closed. Add the binary values of the closed switches and you will know how much the current has increased as compared to S1 closed by itself. See Table 1a. You can see that 256 steps are

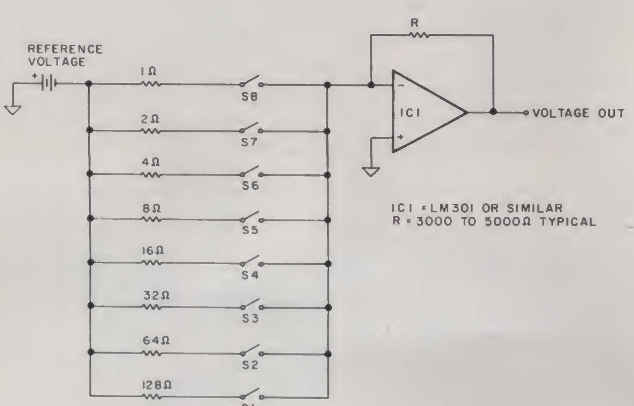


Fig. 1. A simplified digital-to-analog converter. The voltage at the output of IC1 is dependent upon the binary sum of the switches that are operated. The reference voltage is usually taken from the +5 volt supply and is fed through a variable resistor for calibration purposes.

Switches	Decimal Value	Binary Value
S1	1	00000001
S2	2	00000010
S3	4	00000100
S4	8	00001000
S5	16	00010000
S6	32	00100000
S7	64	01000000
S8	128	10000000

*Table 1a. Binary and decimal value of the switches in Fig. 1. Closing any switch will multiply the output voltage of IC1 by the output when only S1 is closed. If S1 closed equals .01 volts output, then S5 closed equals .16 volts output. If more than one switch is closed, the values of all the closed switches are added together and then multiplied by the base value (S1 only). Operate S2, S4 and S7, and the output will be .74 volts ((2 + 8 + 64) * .01) = .74.*

possible (1 + 2 + 4 + 8 + 16 + 32 + 64 + 128 = 255 + 0 = 256), since 0 counts as the first step.

Of course, since the op amp will increase its output voltage in proportion to its input current, the voltage will always be directly related to the binary sum of the switches. In effect, we have converted from digital (the switches) to analog (the op amp output voltage level).

Let's take an example. Suppose 1 microamp of current flows with S1 closed and IC1 converts that current flow to .01 volt. Then opening S1 and closing S2 would cause 2 uA to flow and our output voltage would be .02 volt. Closing S1 and S2 would give an output of .03 volts. See Table 1b. With all of the switches operated, 255 times the base current (1 uA), or 255 uA, would flow, and the output voltage would be 255 X .01, or 2.55, volts.

If we could operate the eight switches of our simple digital-to-analog converter with the eight bits of one of our microprocessor parallel output ports, we could cause any voltage from 0 to 2.55 (in .01 volt steps) to appear at our analog out port by placing the proper digital byte in that parallel port. While this would not be a true analog signal since it would change in .01 volt steps instead of continuously, it would be a fair approximation.

The actual voltage range of the output signal can be determined by the value of the components used to bias the op amp IC1. Most op amp data sheets give this information. See the references.

Fortunately for us, many semiconductor manufacturers produce an integrated circuit digital-to-analog converter on a chip. Motorola calls theirs the MC1408, and at less than $5 it is quite a bargain. One advantage of putting all circuit elements on a single chip is that they are closely matched during the manufacturing process. For you to try to create the same matching with discrete components would be difficult and expensive.

A simplified block diagram of the MC1408 is shown in Fig. 2a. You can see that it contains the switches and resistors of the simple DAC in Fig. 1. It connects directly to a parallel output port. The reference voltage is usually fed through a potentiometer for calibration purposes. The only thing that we need to add is a circuit to convert the output current to a voltage.

Figs. 2b and 2c show two methods of doing this. The unipolar approach (Fig. 2b) would give us a voltage referenced to ground, such as 0 to +2.5 volts. The bipolar circuit (Fig. 2c) would give a voltage that ranged both sides of zero, such as plus or minus 2.5 volts.

After the processor has set a given voltage at the output of the op amp, that voltage will slowly bleed off due to circuit losses. If it is desirable to hold the voltage steady, then it should be refreshed a few times

Binary Value	Decimal Value	Voltage
00000000	0	0
00000001	1	.01
00000010	2	.02
00000011	3	.03
00000100	4	.04
01111111	127	1.27
10000000	128	1.28
10000001	129	1.29
11111101	253	2.53
11111110	254	2.54
11111111	255	2.55

Table 1b. Binary-and-decimal-to-voltage conversion table for the simple DAC in Fig. 1. Each switch is considered to be binary 0 when open and binary 1 when operated. S1 is the least significant (right hand) digit and S8 is the most significant (left hand) digit. 10000001 indicates that S1 and S8 are closed and their total value of 129 (1 + 128) times .01 equals an output of 1.29 volts.

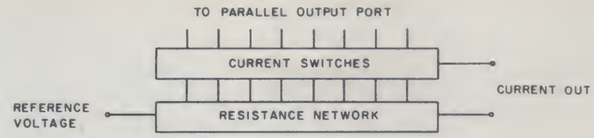
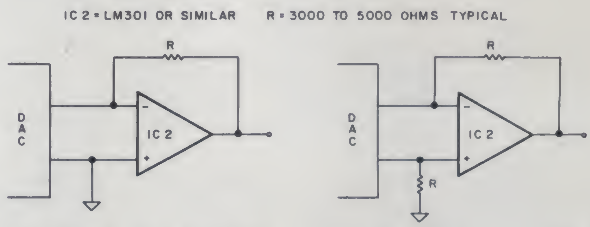


Fig. 2a. Block diagram of the MC1408 digital-to-analog converter IC. This circuit produces essentially the same results as Fig. 1 using all solid-state components. The MC1408 comes in three versions, suffixed L8, L7 and L6. The only difference between them is the degree of accuracy possible. The maximum error with the L8 is ±.19 percent, the L7 is ±.39 percent and the L6 is ±.78 percent. This makes the L8 the most desirable version; however, all three are quite suitable for personal computer use.



Figs. 2b and 2c. The MC1408 is a current output device. IC2 converts this current flow to a voltage level. Fig. 2b produces a voltage referenced to ground, such as 0 to +2.5 volts. Fig. 2c puts out a voltage that ranges both sides of 0, such as +2.5 to −2.5 volts. Linear IC and op amp data books give much more information on circuit configuration and component values.

a second. If the voltage is being changed more than once or twice a second, then refreshing is usually not necessary.

Theory—Analog-to-Digital Conversion

OK, now we can take a digital byte and put it out as an analog (voltage) level. How about the other way around? Can we connect a voltage to an input port and have the processor see the equivalent digital word? Yes, there are many methods to effect this conversion, and we'll look at three, all of which will make use of the MC1408.

We saw how the 1408 converts from digital to analog, but how does it convert back? Actually, it can't, but we can still use it to help us. The first two methods are software intensive; that means that most of the conversion is handled with programming. The third method is completely implemented in hardware and requires no software at all.

Fig. 3 is a basic analog-to-digital converter (ADC) that we'll use in the first two methods. IC3 is our MC1408 DAC, and IC4 is the op amp that converts from current to voltage.

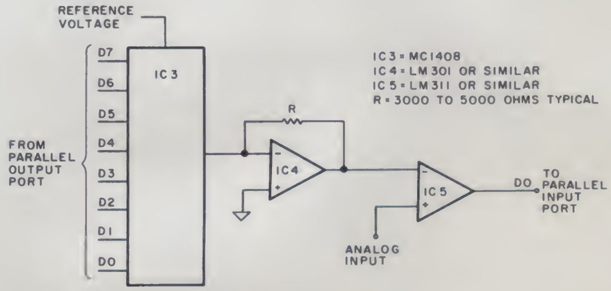


Fig. 3. A basic analog-to-digital converter. The processor puts out trial bytes, and the result out of IC4 is compared with the analog voltage at IC5. When we have a match, the output of IC5 will go low and the processor will know that the last byte sent to the parallel output port was greater than the analog value we want to measure.

Voltage	Decimal Equivalent	Binary Equivalent
+2.54	127	01111111
+2.52	126	01111110
+2.50	125	01111101
.	.	.
.	.	.
.	.	.
+0.06	3	00000011
+0.04	2	00000010
+0.02	1	00000001
0.00	0	00000000
−0.02	255	11111111
−0.04	254	11111110
−0.06	253	11111101
.	.	.
.	.	.
.	.	.
−2.52	130	10000010
−2.54	129	10000001
−2.56	128	10000000

Table 2. Voltage-to-binary-and-decimal conversion in the D + 7A I/O board. The voltage shown on the left when applied to one of the A/D ports produces the decimal or binary equivalent shown on the right. When the decimal value is sent to one of the D/A ports, the voltage shown results. The table runs in .02 volt steps from + 2.54 to − 2.56 volts. Most of the intermediate values have been omitted, but they can easily be found by multiplying positive decimal values by .02. Negative voltages can be figured by using the formula (256 − D).02, where D is the decimal value.*

```
 10 REM-RAMP METHOD OF A/D CONVERSION
 20 LET X=0
 30 LET X=X+1
 40 IF X>255 THEN  PRINT "VOLTAGE TOO HIGH !": GOTO 100
 50 OUT 24,X
 60 LET Y=INP(24)
 70 IF Y=1 THEN  GOTO 30
 80 IF X=1 THEN  PRINT "VOLTAGE TOO LOW !": GOTO 100
 90 PRINT X*.01;"VOLTS DC"
100 END
```

Program A. Written in Processor Technology's Extended Cassette BASIC to implement the ramp method of analog-to-digital conversion. Line 30 steps the variable X by 1, and if X exceeds 255 without a match being made, the out-of-range message in line 40 will be printed. Line 50 sends the value of X to the parallel port, and lines 60 and 70 check to see if we have a match. If not, we go back to line 30, increment X and try again. When Y goes to 0 in line 70 (indicating a match), the value and message in line 90 is printed unless X = 1, in which case the error message in 80 is printed. With a fast BASIC and a slow D/A converter it might be necessary to insert a short pause between lines 50 and 60 to allow time for the conversion process to take place.

So far this is the same as the circuit we discussed in Fig. 2.

However, if we add a comparator (IC5, an LM311, for instance), we have a whole new ball game. The analog voltage we want to convert to digital is tied to the plus input of the comparator, the output of the DAC is tied to negative input and the output of the comparator is tied to one data line (D0) of a parallel input port.

A comparator looks like an op amp but has an unusual property. As long as the voltage applied to the positive input is greater than the voltage applied to the negative input, the output will be a logical 1. When the voltage at the negative input exceeds that of the positive, the output will be a logical 0. In other words, the comparator is comparing the two voltages and letting us know which is greater.

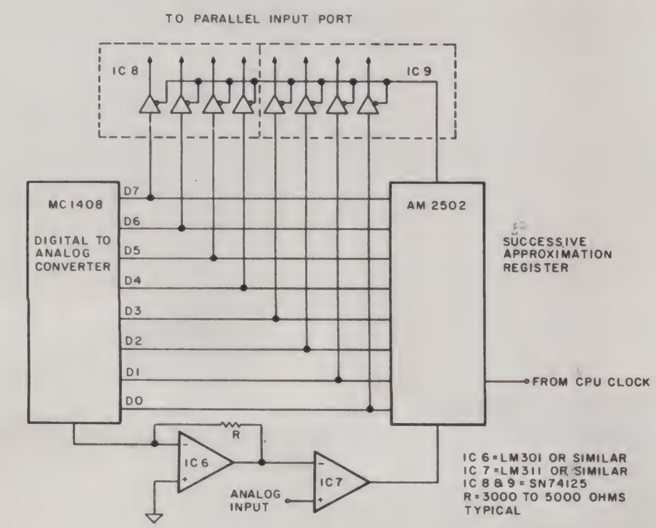


Fig. 4. The successive approximation method of analog-to-digital conversion in hardware. The SAR (successive approximation register) feeds the DAC trial bytes and reads the results in the same way that Program B does with Fig. 3. When a match is made, the SAR gates (IC8 and 9) the digital information to the parallel input port for the processor to read.

Let's look at the first software intensive analog-to-digital conversion method. It is called the "ramp" method. For continuity we'll use the same current and voltage values that we used to explain the DAC in Fig. 1. Say that the voltage we've applied to the analog input is 1.687 volts dc. Of course, we don't know that it is 1.687 yet!

Basically, the ramp method says: Output a digital value, read the input port, if it's not 0 then increase the output value; read the input port, if it's not 0, increase the output value, etc. Specifically, what we'll do is output a 1, which the DAC converts to .01 volt. This is compared with our analog voltage (is .01 greater than 1.687?), and we know it isn't greater because we see a 1 at the parallel input port. So we output a 2 (.02 volts to the comparator), compare (we're still low), output a 3, compare (we're still low), etc.

This goes on and on until the output of the DAC does exceed the analog voltage we are trying to measure. This will occur when we output 169 (1.69 volts to the comparator is greater than 1.687); the output of the comparator will change to 0, and the software knows that we have a match. If we multiply the digital output of 169 by .01, we get 1.69, which is close to 1.687. The answer should always be within .01 since we are comparing in .01 volt steps.

A BASIC program to implement the ramp method of analog-to-digital conversion might look like the listing in Program A. Using 1.687 volts as our analog value, the program would print 1.69 volts dc.

The ramp method is easy to use, requires minimum software and is accurate, but it has one serious drawback—it is slow. Depending upon the value of the voltage that we want to measure, it could take as many as 255 tries before we got a match. A better method, called "successive approximation," can use the same hardware as above, and all we have to do is write a little more software. The successive approximation method always requires seven times through a trial loop.

In successive approximation we divide our range in half, compare our midpoint with the analog voltage and, if our midpoint is higher, discard the upper half of our range. If the midpoint is lower, we discard the

```
110 REM-SUCCESSIVE APPROXIMATION METHOD OF ADC
120 DIM V(8)
130 FOR J=1 TO 8
140   READ V(J)
150 NEXT J
160 DATA 128,64,32,16,8,4,2,1
170 LET X=128
180 FOR I=1 TO 7
190   OUT 24,X
200   LET Y=INP(24)
210   IF Y=1 THEN  LET X=X+V(I+1)
220   IF Y=0 THEN  LET X=(X-V((I))+V(I+1)
230 NEXT I
240 IF X=255 THEN  PRINT "VOLTAGE TOO HIGH !": GOTO 270
250 IF X=1 THEN  PRINT "VOLTAGE TOO LOW !": GOTO 270
260 PRINT X*.01;"VOLTS DC"
270 END
```

Program B. A successive approximation analog-to-digital conversion program used in conjunction with Fig. 3. This method divides the range in half seven times to find the digital equivalent to an analog value. Lines 120 to 160 load the values of each of the eight digital bits. Line 170 sets the first midpoint, and lines 180 to 230 put out the trial, check the result and then select either the upper or lower half of the test range. After seven trials, X is determined to be the closest digital byte to the analog value and is multiplied by .01 and printed. If X is too high or too low, then the error message in line 240 or 250 will be printed. This is much faster than Program A. As in Program A, a short pause might be needed between lines 190 and 200 (195 FOR J = 1 TO 2: NEXT J).

```
280 REM-STEP VOLTAGE GENERATOR
290 FOR I=128 TO 255
300   OUT 25,I
310   FOR J=1 TO 600
320   NEXT J
330 NEXT I
340 FOR I=0 TO 127
350   OUT 25,I
360   FOR J=1 TO 600
370   NEXT J
380 NEXT I
390 END
```

Program C. D/A output demonstration program. The output of D/A port 1 will start at −2.56 volts and each second will increase its output by .02 volts. The J loop in lines 310-320 and 360-370 causes the one-second delay, and the value of J can be increased or decreased as desired.

lower half of the range. Now we take the midpoint of the remaining half and compare again. Doing this seven times will zero right in on the analog value, just as the ramp method did, only much faster.

Program B is the successive approximation method written in BASIC. When we run this program with 1.687 volts applied to our analog input, the answer that is printed on the screen is 1.69 volts dc, which is within .01 volts of the actual value. This readout compares extremely well with most VOMs and VTVMs. In fact, it is almost impossible to read a mechanical meter that closely. Either of the previous BASIC programs could just as easily have been implemented in assembly language.

The third method of analog-to-digital conversion that we'll discuss also uses successive approximation but is all done with hardware. Fig. 4 is a simple A/D converter using a special IC called a successive approximation register (SAR). An SAR, such as the AM2502, does just about the same thing that Program B does. It tries one bit at a time starting with the most significant bit (D7) until a match is made, and then the digital result is fed to the parallel input port to be read.

**Hardware—
The Cromemco D + 7A I/O**

I am using the Cromemco D + 7A I/O board in my SOL, and from now on all references will pertain to that piece of equipment. The D + 7 contains a parallel output port, a parallel input port, seven digital-to-analog output ports and seven analog-to-digital input ports (see Fig. 5). Quite a handful for a board that retails for $145 in kit form! It is a great value and a great addition to any microprocessor system. See the references for a review of this kit.

The digital-to-analog ports. The D + 7 I/O board uses the MC1408 DAC and the bipolar approach in its analog port levels, and the swing is from +2.54 to −2.56 in .02 volt steps. Table 2 compares the analog voltage with its decimal and binary equivalents. At first glance the negative bytes seem to be listed backwards until you realize that two's complement signed bytes are being used. The most significant bit (D7) is zero for positive values and 1 for negative values. The other seven bits (D6 to D0) are complemented (inverted) for negative values.

Processor Technology's Extended Cassette BASIC, and many others also, allows direct access to the input and output ports with the INP and OUT statements. Y = INP(24) says to assign whatever value is read at input port 24 to the variable Y. OUT 25, 127 means send 127 (in digital form) to output port 25.

If your BASIC does not allow such direct access to I/O ports, it will be necessary to write I/O routines in assembly language and then call them from BASIC. As mentioned, any of the programs in this article could have been written completely in assembly language.

An OUT 25, 127 (127 = binary 01111111) will cause A/D port 1 to go to +2.54 volts, OUT 25, 0 will cause it to go to zero volts and OUT 25, 128 (128 = binary 10000000) will cause it to go to −2.56 volts. Program C will cause the voltage to change in .02 volt steps from −2.56 to +2.54. With a voltmeter connected to A/D port 1, you can watch the voltage increase step by step.

What can we use these ports for? Sound for one thing . . . or better yet, music. In Part 2, un-

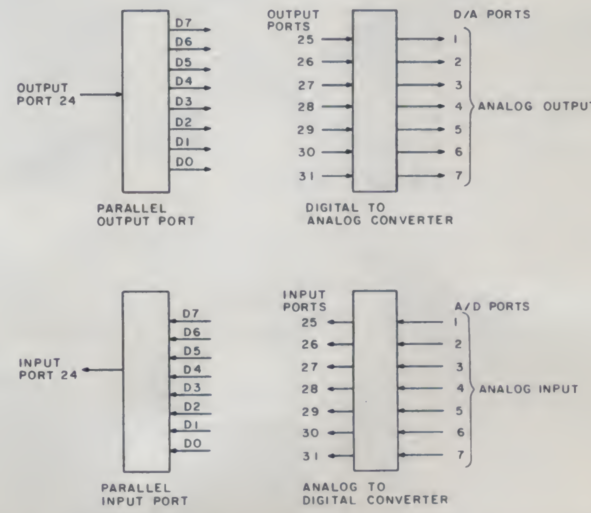


Fig. 5. A block diagram of the Cromemco D + 7A I/O Interface Board. Eight 8080 input and output ports are used. These are shown as ports 24 to 31, but provision is made on the board to strap in other addresses if required. Since all conversion is handled in hardware, it is only necessary to output to the board or input from it in order to implement A/D or D/A conversion.

der applications, we will discuss a programmed function generator that will produce triangle, square or sine waves at any frequency we choose. Two D/A ports could be used to feed the X and Y axes of an oscilloscope for high resolution graphics. Motor control, light level, temperature manipulation for a home heating, cooling or solar energy system and data transmission over phone lines are some other possibilities.

The analog-to-digital ports. The D + 7 A/D inports have the same range and voltage to digital conversion as shown in Table 2. The D + 7 A/D ports use the SAR hardware conversion method of analog-to-digital conversion as discussed in Fig. 4. The only software requirement is to read the desired A/D port.

If you ground A/D port 1 and command X = INP (25):PRINT X, you should get 0 printed on your screen. If you tie port 1 to a +2.54 volt source and run the same program again, you should get 127 on the screen. A −2.56 at port 1 would give 128 on the screen. This is in itself a +2.54 to −2.56 volt high impedance voltmeter, and with the proper scaling resistors and program any range can be measured, as we shall see.

In Part 1 of this article we have learned how the conversion from a digital byte to an analog voltage level is accomplished. We've also discussed the same process in reverse. As a practical implementation of these conversions, the Cromemco D + 7A I/O board has been introduced. If you still have any questions about these processes, it might be advisable to go back and study Part 1 again while waiting for Part 2.

In Part 2 applications for D/A, A/D and parallel digital ports will be presented and explained. These will include sense switches, joysticks for variable input, light and temperature sensors, a ±250 volt digital meter and the control of external devices. See you next month. ■

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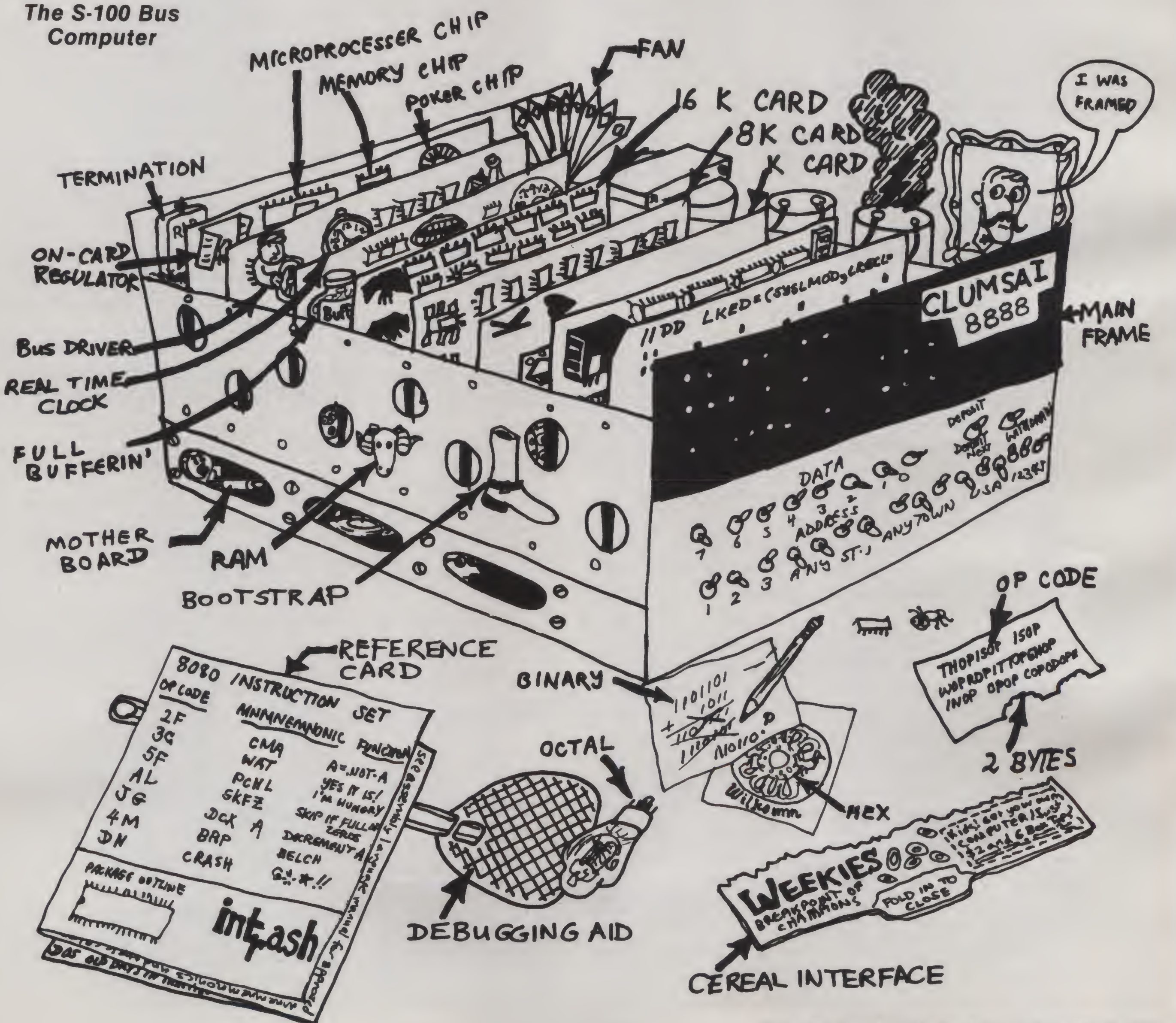
The S-100 Bus Computer



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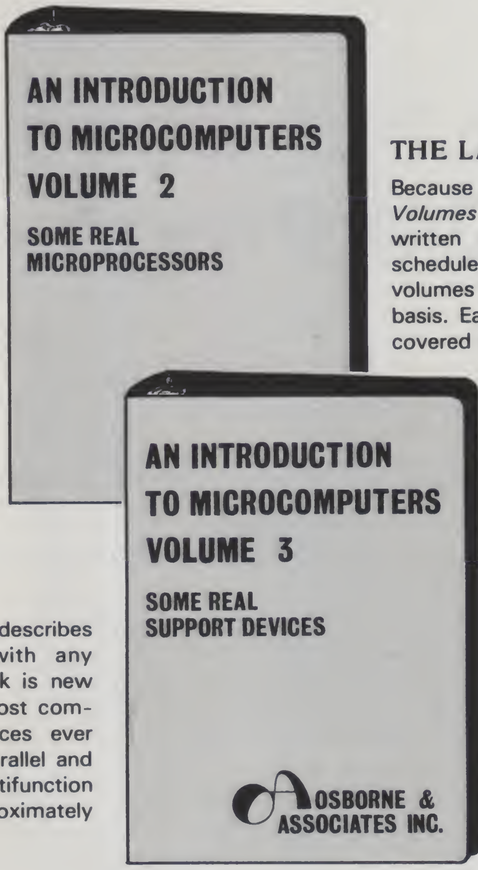

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✓ Reader Service—see page 179

The "El Cheapo" EPROM Programmer

Another EPROM programmer—but wait a minute; check out how little you'll have to spend.

Dr. Ward J. McFarland, Jr.
31 High Street
New Haven CT 06511

Do you believe that you can make an EPROM programmer using only two inexpensive integrated circuits . . . and without using any output ports? Until Intel released the 2758 erasable programmable read-only memory (EPROM), this idea would have been laughable. Now, for as little as $5, you can beef up your system by adding this simple circuit for putting programs or data into permanent storage.

The Intel 2758 offers many advantages over other erasable read-only memory chips. The device has a capacity of 8192 bits, configured as 8 bits × 1024 bytes. Except while programming, only a single +5 volt supply is needed for operation. A standby mode that allows operation at reduced supply current (typically 10 milliamperes) is available. A maximum read access time of 450 nanoseconds allows full speed operation with a one megahertz clock.

What really sets this device apart from the 2708 and other similar devices is its ease of programming. No pulsed high voltage supplies are needed; only 25 volts dc applied to one pin and a single TTL-compatible programming pulse to another pin are required for each location you want to program. In addition, single locations may be easily programmed in any desired sequence without the need to cycle through the entire memory. Both hardware and software requirements are minimal and should require only a few hours' work.

Fig. 1 shows the pin configu-

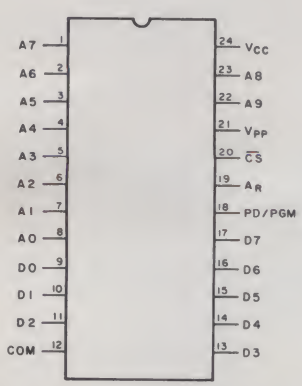

Fig. 1. Pin configuration of Intel 2758 EPROM (top view).

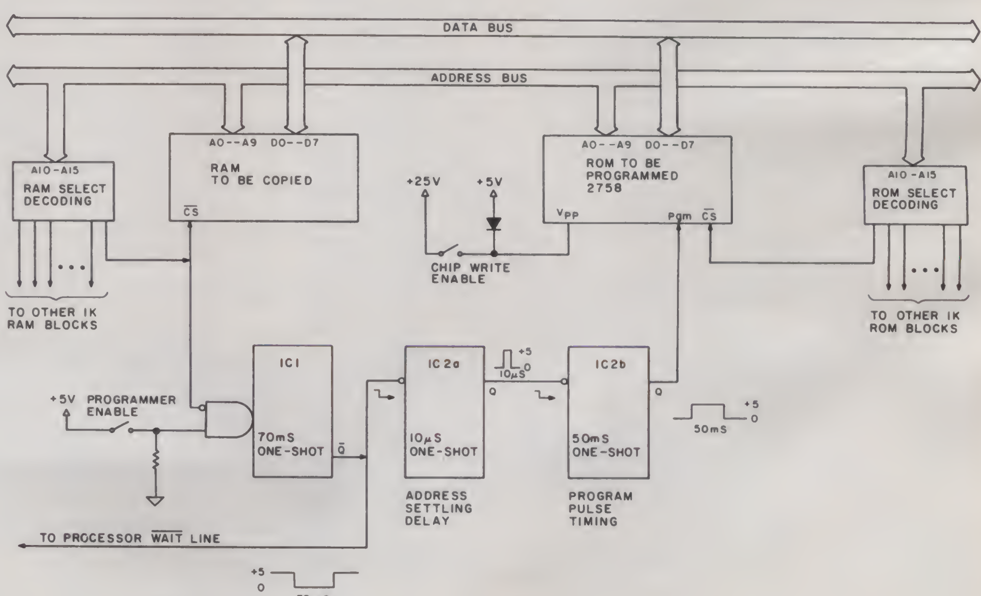

Fig. 2. Block diagram of 2758 programmer.

ration of the 2758, and Table 1 shows its available operating modes. Pin 19 (A_R) has no function but must be grounded. With V_{pp} (pin 21) at +5 volts, the device operates as a read-only memory (ROM); normal or power-down operation can then be selected with Pd/Pgm (pin 18). In battery-powered systems or applications where current must be minimized, the power savings using this mode can be substantial.

Pin 20 ($\overline{CS}$) serves as a chip select line, with the 2758 enabled when this line is low. The data lines float when the device is not being read or programmed, allowing direct wired-or connections with the system data bus. During reading and programming, the data and address lines present MOS-type loads (about 10 microamperes), which you should be able to drive without additional buffering.

The 2758 is put into a programming mode by raising V_{pp} (pin 21) to +25 volts. Applying a 50 millisecond, +5 volt pulse to Pd/Pgm (pin 18) programs the data present on the data bus into the location selected by the address bus. One pulse is sufficient to program any location, and data can be programmed into any location at any time; all 1024 bytes can be programmed in less than a minute.

Although data can be read from the 2758 with V_{pp} at +25 volts for verification, Intel advises against leaving this line high for prolonged periods. Note that $\overline{CS}$ (pin 20) must remain high during programming.

Table 2 summarizes some of the electrical specifications of the 2758. Initially and after erasing, all bits are set to "1." Data is programmed by storing a "0" in each appropriate location. A "0" can only be reset to a "1" by erasing the entire 8192 bits. Erasing the device is simply a matter of providing sufficient exposure to shortwave ultraviolet light (the kind that is dangerous to unshielded eyes and skin).

If you do not have access to a commercial eraser, you can purchase a shortwave UV mineral lamp from a local scientific supply house for \$50 or \$60.

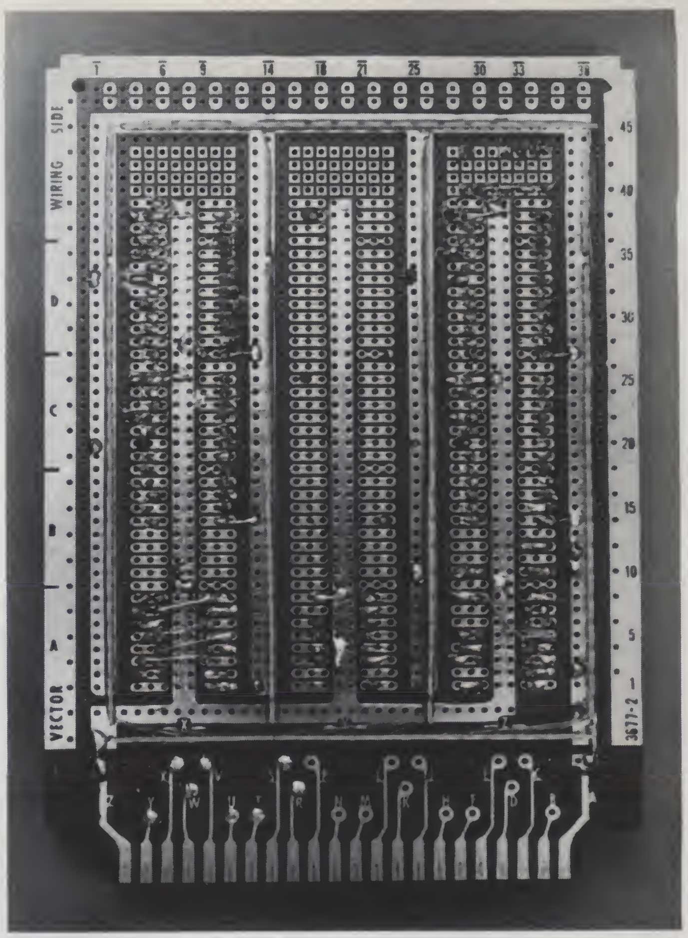

Photo 2. Bottom view of 2758 programmer. Use of special plastic guide rails (Vector) makes routing wires much more organized. All wiring was done directly on ordinary IC sockets using Vector wiring pencil with solderable insulated wire.

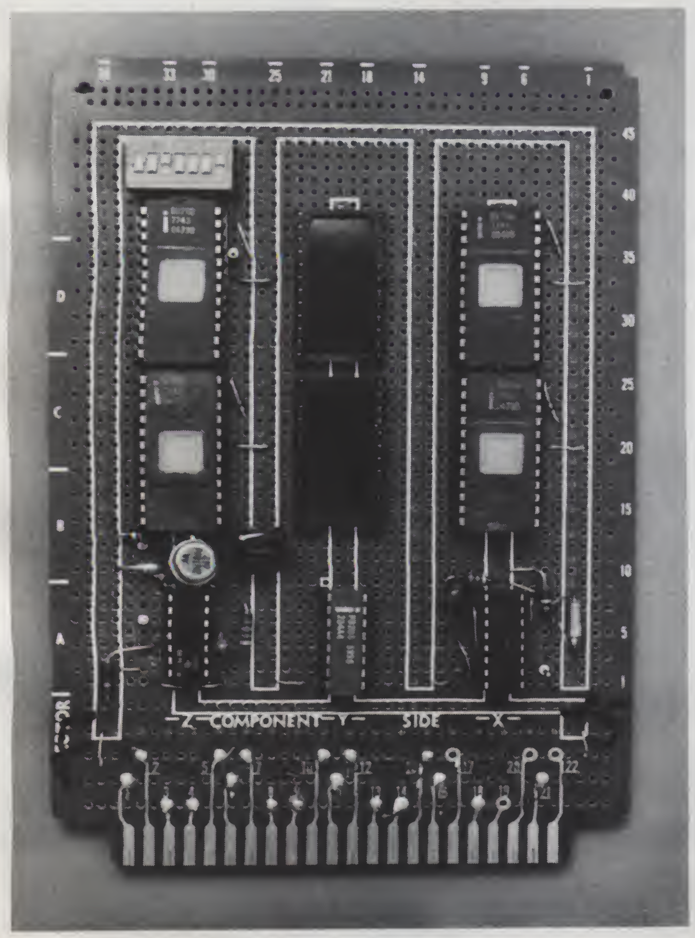

Photo 1. Top view of the completed 2758 EPROM programmer. Space is available for six 2758s (four are shown). DIP switch is used to enable the programmer and select the device to be programmed.

V_{pp} (pin 21)	Pd/Pgm (pin 18)	$\overline{CS}$ (pin 20)	Data Bus	Mode
+5 V	+5 V	don't care	float	Standby
+5	don't care	+5	float	Deselect
+5	0	0	D_{out}	Read
+25	0	0	D_{out}	Program Verify
+25	0	+5	float	Program Inhibit
+25	+5 (pulsed)	+5	D_{in}	Program

A_R (pin 19) at 0 V

Table 1. Operating modes for Intel 2758 EPROM.

The most inexpensive approach I could find was to use a germicidal UV lamp (Sylvania G8T5 or equivalent) obtained at a local lighting distributor for $12, plus $9 for a socket and starter. A 30-minute exposure with this lamp at one inch from the 2758 erases the device easily.

Circuit Design

Fig. 2 shows a block diagram of a simple but effective 2758 programmer. The 2758 is wired directly to the address and data buses just as any other memory device, with appropriate high-order address decoding to generate $\overline{\text{CS}}$.

The circuit design takes advantage of the fact that many microprocessors have a mode where the data and address buses can be "frozen" for a sufficient length of time to program the word on the data bus into the 2758. The "el cheapo" programmer forces this to occur whenever the processor reads data from a preprogrammed block of memory; otherwise, the processor operates normally. Thus, data from this preprogrammed area of memory is directly copied into the 2758—whenever a location in that area of memory is read, the processor is forced into a wait cycle until the data is programmed into the corresponding location (same A0-A9) in the 2758.

The sequence of operations occurring during programming is outlined in Table 3, and a detailed schematic of the programmer circuitry is shown in Fig. 3. IC1 is a one-shot multivibrator used to pull down the $\overline{\text{WAIT}}$ line of my 6502-based system and to initiate the 70 millisecond programming cycle. $\overline{\text{WAIT}}$ can be used with a Z-80-based system and READY can be used with an 8080. IC1 is triggered only when both the programmer enable line is high (pin 5 of IC1) and when the chip select line for the preprogrammed area of memory to be copied goes low.

As the $\overline{\text{WAIT}}$ line goes low, IC2 is triggered to provide a 10 microsecond delay for the address and data buses to settle completely prior to programming. After this delay, IC2b provides the 50 millisecond +5 volt pulse for actually programming the 2758. These

$V_{CC} = +5\text{ V} \pm 5\%$
I_C = 50-100 mA (read or program)
= 10-25 mA (standby)
$V_{PP} = V_{CC} \pm 0.6$ V @ 5 mA (read or standby)
= 25 ± 1 V @ 30 mA (program)
Read Access Time = 450 ns max
Address Setup Time (programming) = 2 μs
Program Pulse Width = 50 ± 5 ms
Input load = 10 μA @ 6 pF
Output Drive = 1 TTL equivalent load
Input and output levels TTL and CMOS compatible

Table 2. Electrical specifications of Intel 2758.

1. CPU starts read cycle to read data from buffer RAM area.
2. IC1 is triggered when buffer RAM select line goes low.
3. IC1 pulls CPU $\overline{\text{WAIT}}$ line low, "freezing" the address from the CPU and the data from RAM on the appropriate buses.
4. After time for address and data to settle, a 50 ms pulse is applied to program the 2758.
5. After a total of 70 ms from the start of the $\overline{\text{WAIT}}$ mode, IC1 completes its cycle and the CPU resumes processing with the new word programmed into the 2758.

Table 3. Sequence of operations during programming of a new word into the 2758.

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three one-shots and a +25 volt supply make the simplest 2758 programmer.

If you only need 1K or less of permanent memory, simply leave the 2758 in the same socket you used for programming. If you already have sockets available for 2708 programmable memory chips, simply rewire pins 19 and 21 (and pin 18 if you want to program them in these sockets) to substitute the 2758. The two ICs and the few discrete components should easily fit in an unused corner of a board already in your system and cost only about $5 (exclusive of sockets, switches and address decoding).

Photo 1 shows the completed programmer. Besides the programmer circuitry, sockets for six 2758s are provided, along with an address decoder for decoding up to eight 1K blocks of memory. Everything is mounted on a 4 1/2×6 1/2 inch (11.4 × 16.5 cm) Vector prototyping plugboard hand-wired with a Vector wiring pencil (wire-wrap would also work nicely). A DIP rocker switch

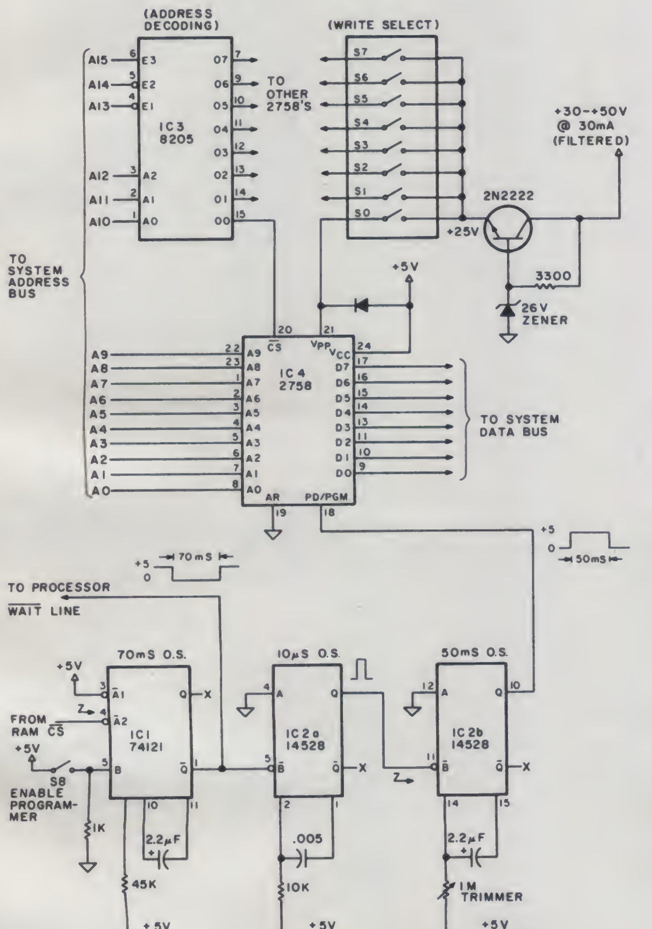

Fig. 3. 2758 programmer schematic.

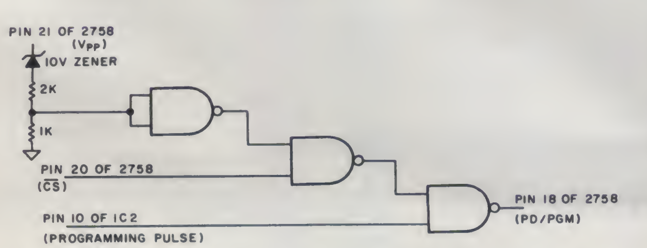

Fig. 4. Proposed power-down logic for 2758 programmer.

Reader Service—see page 179

with seven SPST switches is used to enable the programmer and to connect the +25 volt supply to the particular 2758 being programmed.

With the decoding scheme shown in Fig. 3, the 2758s are located between location 8000-97FF; in my system, a block of volatile programmable memory (RAM), arbitrarily placed at 1000-13FF(hex), is used as a buffer for storing the data to be copied. I have not included any provisions for using the power-down mode in this design, but this can be accomplished easily with a few additional gates as outlined in Fig. 4. Remember that the power-down logic must be disabled while programming. Output ports could be used instead of switches to enable the programmer or connect the +25 volt supply to the desired chip (using relays or transistor switches).

Modification

A few comments about circuit requirements are in order if you are considering modifying the design. To halt the processor reliably, the $\overline{\text{WAIT}}$ line must go low quickly after the RAM $\overline{\text{CS}}$ goes low (in the same clock cycle); therefore, nothing slower than TTL should be used for IC1. IC2a and b are not critical

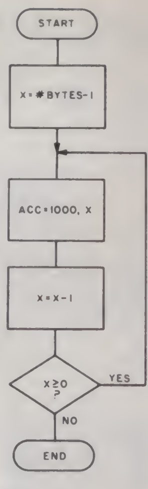

Fig. 6a. Simple routine for programming the 2758 with a large block of data (up to 256 bytes for 6502).

regarding switching speed, and CMOS was chosen over TTL here because of lower power consumption and more convenient configuration.

The 50 millisecond programming pulse has been given only a ±5 millisecond tolerance by Intel, and this interval should be set accurately with potentiometer R4 using a calibrated oscilloscope, a frequency counter or perhaps a software timing routine. The delay of IC1 should always exceed the sum of the delays of IC2a and b; the

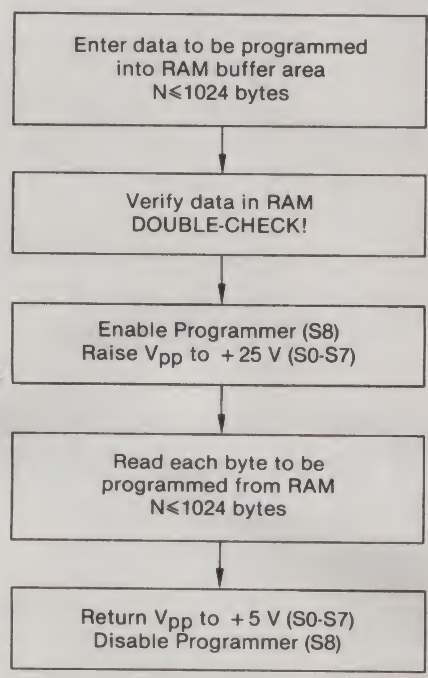

Fig. 5. Flow diagram for programming Intel 2758.

```
0100          A6 00      LDX Length     location 00 contains block length
0102          CA         DEX
0103   next   BD 00 10   LDA  1000, X   RAM buffer starts at 1000
0106          CA         DEX
0107          10 FA      BPL next       loop until done
0109          00 (60)    BRK (RTS)
```

Fig. 6b. Simple 6502 program for programming the 2758 with up to 256 bytes at a time.

70 millisecond delay used in Figs. 2 and 3 is more than sufficient.

The specifications require that the +25 volt supply be regulated to ±1 volt accuracy; the simple zener regulator with series pass transistor shown in Fig. 3 should be sufficient, but check the voltage as zener tolerances can be ±10 percent. If multiple programmable memory chips are to be programmed simultaneously, a more powerful supply should be considered. The diode clamp on pin 21 keeps V_{pp} at about 4.5 volts when the +25 volt supply is switched out of circuit. The Intel 8205 three-to-eight decoder shown in Fig. 3 for high-order address decoding may be replaced by any other suitable address decoder (such as the 74 LS138).

Fig. 5 shows a flow diagram of the operations necessary to program a block of N bytes into the 2758 (N≤1024). After the data is loaded into the memory buffer (with the eight low-order addresses corresponding to those desired for the final ROM location), it should be verified and double-checked (unless *you* like reentering all the data after erasing the entire chip just for one wrong entry!).

Next, the programmer is enabled by raising pin 5 of IC1 to +5 volts, and +25 volts is applied to pin 21 (V_{pp}). The data to be programmed is then simply read from the RAM byte by byte; each of these read operations initiates a 70 millisecond wait cycle and triggers the programming circuit, which programs one location of PROM. When all locations are entered, the data may be read directly from the 2758 to verify accuracy.

When you are finished programming, remember to lower V_{pp} back to +5 volts to protect the 2758, and remember to disable IC1 so as not to slow processing time. A simple software routine for reading (and therefore programming) up to 256 consecutive locations from the buffer RAM area is shown in Fig. 6; note that only nine words of 6502 assembly language are necessary for this routine.

If you have been intimidated by the complex design of most home-brew PROM programmers or by the expense of buying a commercial unit (which might or might not really be compatible with your system's bus structure anyway), then perhaps the 2758 is the answer for you, too. As this device has only been available for a few months, the price is still relatively high; single quantity prices seem to run about $38 as of mid-November. However, since competition seems to abound in this industry, I expect the price to come down rapidly to a level competitive with the 2708, which is now available for under $15. (Remember its price a year ago?)

So far, I have used this circuit to program over 9K bytes for my system and others with no copying errors. As you might suppose, I have been thoroughly sold on the simplicity and reliability of the 2758. Anyone ready for *the 16K version?* ■

For those interested in obtaining a 2758 to experiment with, Applied Autonomics Corporation of 31 High Street, New Haven CT 06511, will make the chip available (unprogrammed) for $32.50 plus $1 postage and handling (Connecticut residents, add 7 percent sales tax).

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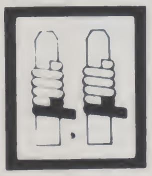

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Is Your Video Monitor Dangerous?

If you've ever worried about frying your eyes while you're staring at your CRT, run those same eyes over this article and see what some experts have to say about the subject.

Sherman P. Wantz
424 NW Lakeview Dr.
Sebring FL 33870

As is usual each time I get a new toy, I overdid it the first time I got my SWTP 6800 up and running. For five hours I slumped over my terminal's keyboard, focusing my attention on the screen of my converted 19-inch television set. The strain was enough to irritate anyone's eyes, and mine felt dry and drawn.

I had been sitting four feet from the monitor, staring directly down the electron gun of its cathode-ray tube (CRT) — a tube that used 15,000 volts to accelerate its beam of charged particles directly at my eyes. Little wonder, then, that my eyes felt tired.

Then, an alarming pair of questions came to mind. (1) If I continue staring at my monitor night after night, will those electrons damage my eyes — permanently? (2) Does that electron stream in the CRT pose any other threat to my health?

I recalled the dire warnings that several ophthalmologists had issued during the early days of television. Looking intently at a TV picture for an extended period of time may be injurious to the eyes, they had claimed, adding that an entire generation was endangering its sight because of a daily diet of television viewing.

I remembered, too, a more recent government agency's warning that parents should not allow their children to lie on the floor watching TV with their legs stretched out beneath the television set's cabinet. Some sets, the warning stated, allowed X rays to escape downward from the receiver's high voltage power supply and could damage those young legs.

I'm a worrier by nature so I was not too surprised to find myself considering giving up my new and fascinating computer hobby. My fears intensified when I considered that X rays are produced when electrons, accelerated by high voltages, strike an obstacle while traveling in a vacuum — as they do when they impinge on the coated screen of a CRT.

There must be many thousands of computer terminal monitors in use across the country. Hasn't the question of potential radiation hazard to those who work continually in front of such monitors occurred to others?

With encouragement from *Kilobaud*'s editors, I researched that question. In addition to contacting every identifiable U.S. manufacturer of television sets and computer monitors listed in Standard and Poor's Register, I wrote to several universities and federal agencies seeking information on the question of radiation leakage.

TV Manufacturers Respond

Replies from manufacturers of television sets and monitors arrived promptly. Typical of the television industry's position was that expressed by the General Telephone and Electronics Corp., makers of Sylvania equipment.

In a bulletin issued in 1969, Sylvania's medical director, Harry E. Tebrock, MD, reported: "Sylvania subjects its television production lines to exacting scientific tests for emission and X-radiation. . . . These tests employ stringent government-accepted and industry-accepted methods of measurement."

Zenith Radio Corp.'s vice-president for consumer affairs, N. W. Aram, pointed out that: "The Bureau of Radiological Health has established X-radiation limits for television receivers under the Radiation Control Act of 1968. This limit is 0.5 milliroentgens per hour, measured at a distance of five centimeters from any surface of the television receiver." (A roentgen (pronounced rent-gan) is a unit of radioactive dose of exposure; a milliroentgen is 1000th of a roentgen.)

"The limit," Aram said, "was selected on a very conservative basis such that the average television viewer using a receiver operating at the limit would receive 5 percent as much radiation from the television receiver in one year's time as he would receive from the natural background radiation at average sea-level conditions."

Zenith Radio supplied me with a technical paper that had been prepared by its radiation safety officer, Stanley D. Savic. The paper has since been distributed by the U.S. Department of Health, Education and Welfare.

Savic's paper described a test program conducted in 1968 in which each of 15,157 employees working on Zenith's television receiver production and test lines at

three separate plants wore X-ray film badges for ten work days. Inspection of the film badges at the end of the test period showed that "...not any single badge showed any radiation at or above the minimum detectable exposure."

Following that test, 162 Zenith color-television production-line repairmen were provided thermoluminescent ring badges, which they wore for six months. The object of this test was to determine whether any hazard existed from hand exposure to malfunctioning TV sets.

Typically, Zenith found that a factory repairman worked on 30 malfunctioning sets per day, considerably more, the study concluded, than a field serviceman might experience in repairing television receivers. Of the 162 ring badges worn during the half-year test, only 13 showed any indication of radiation. Since the test subjects had been allowed to wear the ring badges at home as well as at work, no scientifically acceptable explanation for the 13 cases of measurable radiation was presented. (All but one exposure reading was 20 milliroentgens or less.)

As a result of his test program, Savic concluded: "The potential for an accidental overexposure to low energy X-radiation from home television receivers to television assemblers and repairmen is negligible and virtually nonexistent."

John Blair, Raytheon Company's director of research, addressed his remarks directly to computer terminal monitors rather than commenting on TV sets converted by hobbyists for use as video display terminals. "The operating voltage of CRTs used for computer displays is much lower than in color TV tubes; therefore, X-ray emission is not any kind of potential hazard. Conversely, there is no ophthalmological evidence of eye damage associated with light emission from CRTs."

After having received those and similar replies from members of the TV industry, I began to feel better about my converted television set monitor. But, I still had a nagging feeling that there might be more to the story.

Would a TV manufacturer be likely to admit that his set produced radiation at levels harmful to users of his equipment? An innate skepticism warned against my accepting that answer.

What Computer Terminal Makers Said

Comments received from producers of computer terminals were even more reassuring than those received from television set manufacturers.

Robert J. Duggan, vice-president for engineering development, Information Systems Division, Bunker Ramo, supplied a May 1975 Underwriters Laboratories, Inc., (UL) report on one of his company's terminal units. Senior project engineer for UL, Charles Haeseker, explained in the report that he had adjusted the Bunker Ramo monitor's brilliance control to its maximum position and then surveyed the terminal for X-radiation using a Victoreen Model 440F-C radiation rate meter.

"The results of this X-radiation test showed that on the zero-to-one milliroentgen per hour scale, there was no indication of any X-radiation," Haeseker reported.

Hewlett-Packard Company's B. M. Oliver, vice-president for research and development, pointed out that "... the penetrating power of an X ray depends on the energy of the electrons that are stopped at the target, in this case the (CRT) screen. For 30 kilovolt electrons, a fraction of an inch of lead glass provides ample shielding. Cathode-ray tubes do not produce gamma rays," he added.

IBM's Martin J. Hamer stated that all of his company's CRT displays are tested for compliance with the federal Radiation Control for Health and Safety Act of 1968.

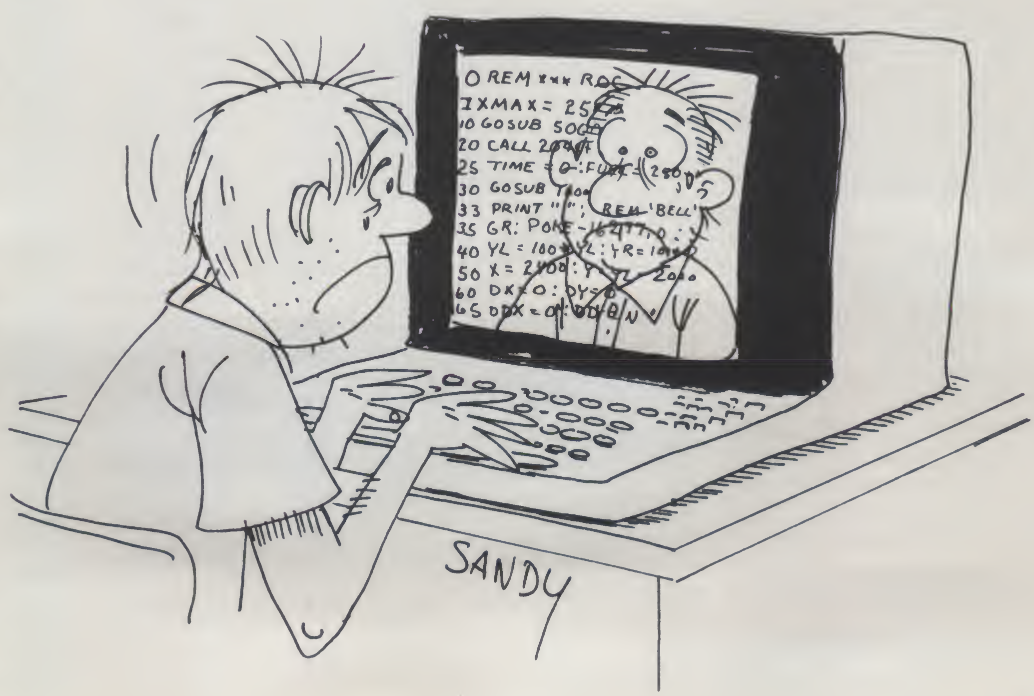
"Those standards specify that X-radiation levels shall not exceed 0.5 milliroentgens per hour when measured approximately two inches from the surface of the unit," Hamer said. "Our CRT displays, when tested, emit no X rays above normal background level X-radiation (X-radiation present in the environment), which varies between 0.05 to 0.1 milliroentgens per hour."

IBM's CRT displays use high-voltage power supplies that produce up to 16,000 volts. Even if a circuit failure were to raise the CRT's anode voltage to 25,000 volts, Hamer said, other component failure would result, disabling the unit rather than increasing its X-radiation.

Tests by the Bureau of Radiological Health

After reading Hewlett-Packard and IBM's replies, I became aware that X-radiation in a computer display terminal unit is associated with the high-voltage power supply as well as with the CRT itself. This fact was confirmed by the response I received from John C. Villforth, director of the Bureau of Radiological Health, Department of Health, Education and Welfare.

"The X-ray emission of a CRT is strongly dependent on the value of the electron accelerating voltage," Villforth said. "The CRTs in the



few terminals we have investigated have been operating at voltages considerably lower than the voltage at which the tube is designed to operate in a television receiver, and we have observed no X-ray emission." Villforth then introduced a point that is significant to us computer hobbyists.

"We recognize," he said, "that hobbyists may use and adapt color television receivers for use as CRT mini or microcomputer terminals." "Of course," he continued, "it may be possible for hobbyists to modify and redesign the electronic circuits of a color television receiver so that they will no longer result in a safe situation." "This," Villforth warned, "would have to be done deliberately and should be discouraged."

According to Villforth, strontium and lead have been added to the glass panels used in TV sets and in most monitors to reduce X-ray emission. "Many, though not all, computer terminals use CRTs designed for use in television receivers," he said.

The Bureau of Radiological Health conducts and supports studies to evaluate the effects of exposure to ionizing radiation. These include studies that examine the delayed effects of exposure to low levels of radiation.

The Bureau's investigations, thus far, have identified increased childhood leukemia as a risk associated with subjecting the embryo and fetus during pregnancy to levels of the order of 0.5 to 2.0 RAD (Radiation Absorbed Dose). The Bureau's studies have also revealed an increased risk of delayed thyroid neoplasm (tumors) when the thyroid gland is exposed to radiation levels of about 6.5 RAD.

But those levels of X-radiation intensity are far above the levels we are concerned with as we pursue our microcomputer hobby.

The Surgeon General Speaks

A brochure entitled "What's being done about X rays from home TV sets," published by the U.S. Department of Health, Education and Welfare, states: "The Surgeon General of the Public Health Service has said he believes that TV X rays do not have much potential for biological damage. In fact, there is no evidence that TV receiver X-radiation has resulted in human injury."

That statement by the Surgeon General should just about end our worries that CRT monitors pose a particular cause for alarm. Right?

Well, not quite.

The collective opinion among experts in the field today is clear insofar as X-ray hazards are concerned: no problem with properly operated CRT monitors.

But what about potential eye damage? That was my initial worry — and is yours too if you've given it any thought. Until recently, the same confident response to the question of possible hazard to humans might have been given by the experts: not to worry.

Mike Wallace Investigates

Alleged eye damage resulting from radiation received national attention on June 19, 1977, when Mike Wallace examined the problem on CBS's "60 Minutes." I obtained a transcript of that particular program after several friends told me that experts interviewed by Wallace had linked cathode-ray tube viewing to eye disorders — particularly cataracts.

Wallace interviewed Joe Towne, a former air force sergeant, who had developed cataracts in both eyes. Towne claimed that his cataracts had been caused by extended exposure to low-level microwave radiation received while he served as a technician aboard an air force EC-121 flying radar station.

Backed by Dr. Milton Zarat, professor of ophthalmology at New York University, the surgeon who operated on the former airman's eyes, Towne won an out-of-court settlement of $50,000 from Lockheed, the company that developed the equipment Towne had worked on.

Although Lockheed settled the claim, the company denied any liability for Towne's eye condition. It is significant that the radiation blamed for Towne's cataracts was microwave, not X rays.

In his program, Wallace also revealed that the Department of Labor had paid six disability claims submitted by air traffic controllers who had developed cataracts. The claimants and Dr. Zarat, who supported them, pointed to nearby radars, not to cathode-ray tubes, as the principal producer of their eye disorders.

The "60 Minutes" report was directed at exploring the effects of microwave radiation that produces an entirely different array of problems from the ones we computer hobbyists face in our homes.

NIOSH Field Team's Survey

Early in 1977, the National Institute For Occupational Safety and Health (NIOSH), Cincinnati OH, entered into a controversy between the Newspaper Guild and the *New York Times*. NIOSH agreed to conduct a field survey to evaluate conditions faced by *Times* employees who use computer monitors.

NIOSH recognized the significance of the Newspaper Guild's complaint. "Video display terminals (VDTs) are making inroads into office managerial procedures with their ability to rapidly display letters, numbers and other symbols," the NIOSH survey reported. "Although exact figures on the numbers of such devices are not available, it is estimated that between five and ten million units are currently in use."

NIOSH's final report, entitled "An Electromagnetic Radiation Survey of Selected Video Display Terminals," describes methods and procedures used by its engineers who tested video terminals at *New York Times'* offices under conditions of actual use.

Since most regions of the electromagnetic spectrum have been suspected of producing cataracts, the NIOSH field team attempted to measure all radiation emitted by the VDTs selected for test. To document levels related to eyestrain, luminance measurements were also made.

Readings of radio frequencies, infrared, visible light and ultraviolet emissions were taken on the three types of terminals used at the *New York Times*.

No X-ray measurements were taken by NIOSH because, earlier in the year, the *New York Times'* insurer had tested 67 of the publisher's terminals for X-radiation levels and had found no measurable leakage. Since the insurance company's findings coincided with NIOSH's previous tests made on similar terminal devices, NIOSH felt no need to repeat the X-ray tests.

The NIOSH evaluation concluded that ". . . the VDTs surveyed do not appear capable of producing cataracts or even present an occupational ocular radiation hazard."

Of particular significance to microcomputer hobbyists is a section of the NIOSH survey team's report that links video terminal use and the incidence of eye fatigue to the user's age, posture, wearing of eyeglasses and time spent staring at the terminal's CRT. The report also links eyestrain with the position of the monitor and reflections produced by overhead or other background lighting found in the vicinity of the monitor.

Not All Fears Allayed

Even after the NIOSH report is published and distributed, doubts are sure to

continue. News media revelations of scientific experts' inability to predict the long-term effects of numerous potential dangers — from artificial sweeteners to insecticides — adds to the feeling of unease. Insufficient evidence exists at present to settle the eye-damage question.

Dr. Charlotte Silverman, deputy director, Division of Biological Effects, Bureau of Radiological Health, claims that ionizing radiation such as X rays can cause cataracts if the exposure involves high doses of at least 200 RAD. Although most controlled exposures to X rays involve only a fraction of a RAD, Dr. Silverman notes that there is generally a cumulative effect from ionizing radiation (i.e., the radiation level tends to build in our bodies as our exposure continues).

Dr. B. M. Oliver of Hewlett-Packard Company claims that fears about CRT viewing's effects on the eye are misplaced. "With regard to eye damage, obviously the ophthalmologists of yesteryear overstated the hazard," he said. "They were as paranoid then as some other doctors are today about other forms of radiation."

Summary

The experts' opinions that video terminal viewing is not injurious to our health has to be regarded as reassuring. But, as usual, not all experts agree — so we are left in limbo. Even though it appears that we need not be unduly worried over X-ray emissions from our CRT monitors, we should continue to be concerned about eyestrain.

Considering that most of us have adapted to reading books and magazines and to typing — all of which require focusing our eyes for extended periods of time at a fixed distance — we should be able to do the same for monitor viewing.

Positioning the monitor to reduce or eliminate reflections from competing room lights, adjusting the monitor's contrast and brightness controls for comfortable viewing, equipping the terminal's CRT with a glare-reducing filter, if necessary, and reducing the period during which our eyes are focused on the screen can help to lessen eyestrain.

So let's get back to our computers, make those adjustments to our terminals to ease eyestrain, and resume writing those useful programs we all need so desperately. ■

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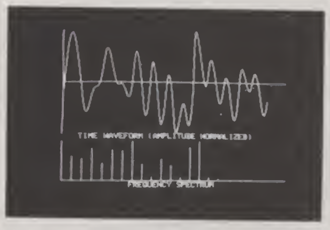

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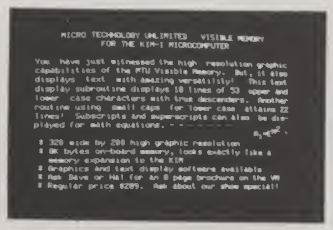

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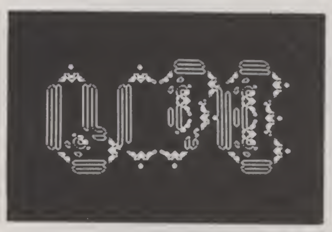

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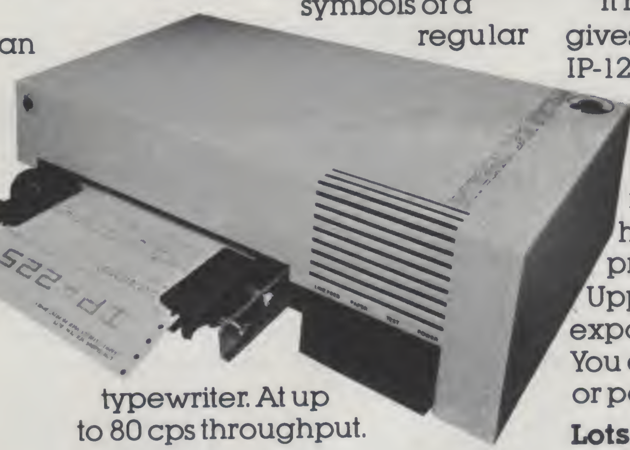

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Some Thoughts on the SWTP Computer System

Pete has lots of thoughts written on this system—five installments so far. Here's part 1.

After owning my SWTP 6800 computer for over a year, I've come across several improvements, changes, add-ons and just plain ideas that may be useful to other SWTP owners as well.

This is the first of several articles that will be devoted to this popular system. In addition, I will also include product reviews of several pieces of hardware and software that I have used. Since this is a convenient way of spreading the news to other SWTP computer users, if you have some other piece of information you think ought to be covered, please send it to me for inclusion in my future articles.

Erasing Your EPROMs

Do you have any 2716s for your CPU board, or are you using an EPROM board? If you use EPROMs, then you will probably need a way of occasionally erasing them. Commercial EPROM erasers cost about $45, but there is a way to make your own much more cheaply.

Erasing an EPROM requires a strong source of ultraviolet (UV) light. Commercial erasers use a UV fluorescent bulb, ballast, socket and other assorted hardware, plus a case. But if you buy your own bulb you can make your own.

The bulb used in most setups is a G4T4 germicidal lamp, which is intended for killing germs. In the symbol, the G stands for germicidal, the digit 4 means it is four Watts, the T stands for tubular and the second 4 gives the diameter of the bulb in eighths of an inch.

If you look at the last page of the General Electric small lamps catalog, you will see a number of other germicidal lamps, one of which may fit a fluorescent fixture you already have. For instance, the G15T8 is a 15-Watt bulb that fits a standard fluorescent desk lamp. The bulb costs about $13.

In use, the EPROM must be placed one inch from the bulb for about 30 minutes. The germicidal bulbs are made of clear glass and emit strong and *dangerous* ultraviolet light. Hence you must take some precautions before you use them for erasing EPROMs. Remember: They are intended for killing germs; they will also kill living cells in the eye or on your skin if you let them.

I use mine in a room that has a lock on the door. I prop up the EPROM on a few small boxes on the desk, directly under the bulb. Then I close my eyes and turn on the lamp. I can tell by the buzzing when it goes on. Then I leave the room and lock the door behind me so no one else can accidentally go in. A half hour later, with my eyes closed, I reenter the room and turn the power off before opening my eyes. If you decide to use the same method, it may be wise to use a box of some kind to cover the lamp when in use.

Above all, do not look at the bulb or at anything that might reflect light from the bulb. If you have any doubts about the safety precautions you can observe, buy a commercial eraser instead of trying to make your own.

Power Supply Problems

The power supply on the SWTP system is capable of running the entire system, but in some cases it may become marginal. There are some easy solutions.

The basic supply consists of a power transformer with two secondary windings. The main winding provides about 7 volts rms, which is rectified by a diode bridge and then filtered by a 91,000 uF capacitor to provide about 7-8 volts dc under load. This is then supplied to each board, where an on-board regulator reduces this to the +5 volts needed by the ICs on that board.

The second winding provides about 22 volts center-tapped, which is rectified by four diodes on the power supply printed circuit board. Since the center tap is grounded, two of the diodes provide about +14 volts, and the other two provide about −14 volts. This is also distributed to the boards; each board that needs positive or negative voltage then has an additional 12 volt regulator that reduces the 14 volts to 12 volts.

The problem is that each of these regulators needs an input voltage about 2 or 3 volts higher than its rated output voltage. In other words, providing 7 volts to a 5 volt regulator or 14 volts to a 12 volt regulator is marginal. It can be done if there is no ripple on the input voltage, but if there is power supply ripple, then the voltage will fall below the 7 or 14 volt level.

When that happens, the board regulators stop regulating and their output voltage also drops. Unfortunately, the output often drops by more than the input. Hence a volt of ripple can appear as two or more volts of noise on the output. This can be disastrous to the proper operation of the system. This also happens during summer brownouts or when the ac line voltage momentarily drops as a nearby appliance goes on.

The problem has been recognized for some time. For example, Smoke Signal Broadcasting sells a PS-1 Power Supply modification kit for $24.95, which changes the power supply to provide plus and minus 16 volts instead of 14 and add about a volt to the 7-8 volt supply. This is a modification that they strongly recommend if you buy their EPROM board, which uses 2708 EPROMs that use current from the plus and minus 14-volt supplies. Their power supply kit avoids a lot of problems in that case.

Other manufacturers avoid the problem in other ways. For instance, Percom's LFD-400 disk system uses a special 12-volt regulator using four transistors, rather than a standard IC regulator, to provide good regulation even with low input voltage.

For most SWTP systems, however, the standard power supply has been quite satisfactory . . . until recently. SWTP has recently started selling a 32K memory board that uses the +14 volt supply. Even in its 16K form, the board's performance with the standard power supply is marginal; with the full 32K expansion it is downright terrible.

I played with it for several days before I narrowed the problem down to the power supply. Just as I was about to start testing to see which supply it was, SWTP came out with a modification.

The original SWTP power supply used 1000 uF capacitors in the plus and minus 14-volt supplies for filtering. In most systems this resulted in acceptable ripple levels on both. But now, when the 32K board is

installed, the ripple on the +14-volt line is close to 2 volts. The latest SWTP systems use about 30,000 uF on this supply, and SWTP recommends that at least 4000 or 5000 uF be added to existing systems. When this is done, power supply ripple drops a lot and memory problems disappear.

In my unit, I have mounted the power supply board upright on small L-brackets and mounted an 18,000 uF can-type capacitor on the bottom of the case in the place formerly occupied by the board. Although this reduces the ripple, the power supply voltages are still marginal, especially if your local power company has a tendency to deliver low voltage. For best operation, further modifications should be made.

The best solution is to buy a constant voltage transformer; unfortunately, this costs $100 and up. Sola Corp., 1717 Busse Road, Elk Grove Village IL 60007, is probably the largest and best-known maker of such transformers. They make two models specifically designed for mini and microcomputers; their model 63-13-114 will handle up to 140 Watts, and model 63-13-125 will handle up to 250 Watts. My fully loaded system (not including terminal and I/O gear) uses under 100 Watts, so the 140-Watt model would be OK.

These units have very impressive specs — input voltage can vary as much as 15 percent, output will remain usable even if the input drops below 75 volts, the output will continue even if the input disappears for as long as 3 milliseconds, etc. Unfortunately, the cost of the 114 and 125 are expensive — $160 and $190, respectively.

Another solution is to adjust a variable transformer as needed to get the proper power supply voltages. This is feasible, but if you accidentally turn the knob to maximum, you can damage the system.

On my system, I have added a 12.6 volt 3 Amp center-tapped filament transformer from Radio Shack in series with the input line as shown in Fig. 1. The secondary is wired so that its voltage adds to the 110-volt line voltage. (If you find that the output is smaller than the input, simply reverse the connections to either the primary or secondary, not both.)

Although Fig. 1 shows a switch that can select either the normal line voltage of 110, 116 or 122 volts, depending on whether only a half or the entire secondary is added, in my system I have the switch permanently wired to the 122-volt position since I have found this necessary. With this change, the line voltage is raised about 10 percent and the 7-8 volt supply provides about 7.7 volts instead of its former 7.1 volts. The 14-volt supplies are also now closer to 15 volts, whereas before they were less than 14 volts.

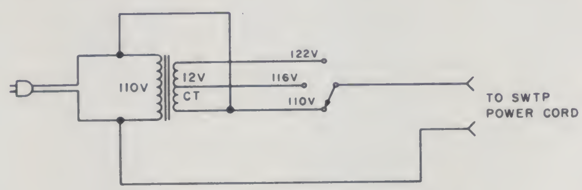

Fig. 1. Boosting the line voltage.

The extra transformer can handle 3 Amperes, so that the circuit can easily handle the entire computer, less printer and other external I/O. My extra transformer is temporarily sitting behind the SWTP case but eventually will be mounted on it or in it.

There are other solutions as well. Harold Mauch of Percom Data Co. showed me his modification. He has added a new transformer, about 30 volts center-tapped, just for the plus and minus 14 volt supplies, which provides close to 20 volts; he then pre-regulates this to about +15 volts and sends that to the 14 volt line. Thus he has double regulation.

Since this frees up the 22 volt center-tapped winding on the main power transformer, he has then connected half of it (11 volts' worth) in series with the 110 volt primary winding (in series opposing) so that it would only need 99 volts for normal operation. Connecting it to the full 110 volt line voltage then ups the secondary by about 10 percent, giving closer to 8 volts on the 7-8 volt line.

I suspect that Smoke Signal Broadcasting uses a similar modification in their supply modification kit; they probably substitute a 24-26 volt transformer for the 22 volt winding and use that winding to up the 7-8 volt power line. In the long run, though, I think my modification is as good and less expensive.

There is one thing to watch out for. Although raising unregulated supply voltages does not affect the output of the regulators, which still provide +5, +12 and −12 volts, it does increase the voltage drop across them. This also raises the power they must dissipate.

Except for the regulators on 4K memory boards, most other regulators run cool enough so that the slight extra heat is no problem. But if you have several 4K boards, monitor their regulator temperature carefully after raising the voltage.

More Power Supply Problems

This fix was suggested by Tom Quay of Lehigh Computer Works, Allentown PA. Some PR-40 printers give trouble because of high ripple on their power supply. As a result, they print a checkerboard pattern on top of the desired characters, which makes the printout messy and hides the actual text.

Tom has found that the power supply filter capacitor sometimes increases its series resistance and lets through more ripple. His recommended solution is to add a few thousand more microfarads in parallel with C1.

The 32K Memory Board

Talking about the SWTP 32K memory board (which, by the way, is made for SWTP by Motorola), have you wondered what chips it uses? That's an interesting question, because you might then buy only the 16K version and get the additional 16K of ICs elsewhere for less.

Actually, there are two versions of the 32K board. The first boards had thirty-two 8K × 1 ICs; the newer boards will have only sixteen 16K × 1 Motorola 6116 chips.

If you call up a Motorola sales office, they will tell you that Motorola does not make an 8K × 1 memory IC! That's true. The 8K IC is really a defective 16K × 1 chip, the same 6116 as is used on the newer boards, except that part of it is bad. The 6116 is actually the same as Intel's 2116 or Mostek's 4116. The same 4116 is also used in the Apple II and the TRS-80 and now sells in the $10 range.

Rather than throw them away, Motorola uses these bad ICs as 8K memories. The same idea is used also in the S.D. Sales Expandoram board. Mostek supplies this IC under the number 4116 when it is perfect and as a 4108 or 4115 when it is partially bad. But Motorola doesn't sell their bad ICs, and so the question is: Can you expand the SWTP/Motorola board by stuffing it with Mostek ICs?

This is where the difficulty starts. Motorola does not apparently sell their bad chips and so they do not tell you which half is bad. Mostek does, but this is not the whole answer. There is a jumper on the SWTP/Motorola 32K board to allow either half of the IC to be good; from this we can figure out which half we need, but there is more to the problem.

Suppose that the Motorola chip is divided internally into two halves and that the address bit A3 is used to select one half or the other. Mostek's equivalent chip, which may be built differently, may use bit A10 to select one half or the other.

Now even if you know which half of the Mostek chip is OK,

you may still not be able to tell whether it will work in the Motorola board unless you know specifically which byte is bad. And if there are two or more bad bytes, the chip may be completely useless unless you change the board wiring. This is because the two bad bytes may both be on the same half of the Mostek chip but may appear to be on different halves when put into the 32K board.

In any case, it's a moot point. Both Motorola and Mostek, and others as well, are improving their memory production to the point where bad chips are getting rare. I have mostly good chips on my 32K board simply because there were not enough bad ones to go around. If you have an older board with only 16K of ICs, you may be able to buy 16 more good 2116/4116/6116 ICs by the time this article appears for a lot less than you'd suspect.

In any case, Motorola is changing the design of the board to use only 16 good chips, and SWTP will only sell the board with a full 32K on it. Hence you will not have the opportunity to expand it yourself. But at least you now know where to get a replacement memory chip if you ever need it.

Cure for Sudden Death

If you have the older MP-A processor board, this may sound familiar. Does your system sometimes die and refuse to come back to life? Pushing RESET does nothing, and the only way you can bring it back is to turn off the power, thereby killing your program. Here is the solution, courtesy of Tom Quay.

During a WAI (wait for interrupt) instruction, the CPU board releases the bus and disconnects itself from it. This is so the bus can be used by other devices, such as a DMA device. When the interrupt comes, it then reconnects itself again and continues.

But the SWTP system does not generally use interrupts. If a program goes crazy — not at all unusual, right? — and happens to execute a WAI, then the computer will stop and wait for an interrupt. Of course, one never comes. Unfortunately, the RESET signal from IC11 pin 3 goes through a gate in IC15, which is Tri-stated during this time. Hence you can push RESET for a week and nothing will happen, because the RESET pulse can't get to the 6800 through IC15.

Tom's solution is simple. There is an extra inverter in IC10, a 7404. Tom connects its input, pin 9, to pin 2 of IC15 and its output, pin 8, to pin 3 of IC15. This parallels that part of IC15 with an inverter that is always on, and so the RESET signal can get through even if everything else is Tri-stated. Neat.

Baud Rate	Pin No.
75	9
200	6
1800	5
2400	3
3600	16
4800	2
7200	17
9600	1

Table 1.

Faster Baud Rates

Do you want to use your serial interface at a rate faster than 1200 baud? Then read on.

The baud rate generator on the CPU board generates baud rate signals up through 9600 baud, but only the rates from 110 through 1200 are brought on the motherboard to the I/O boards. Where and how do you get the others?

SWTP Newsletter 1a gave the pins on the MC14411 baud rate generator that provide the other baud rate clock signals (see Table 1). The problem is how to get these from the CPU board to the I/O boards.

The customary way is to use the UD (user defined) lines on the motherboard. For instance, to get 9600 baud to a port, you jumper pin 1 of the MC14411 to the UD1 pin on the CPU board, then jumper UD1 to UD3 on the motherboard and take the baud rate signal from UD3 on the I/O board. This requires that you put in several jumpers, as well as unplug everything to get the motherboard out. It also leaves the baud rate signal unbuffered as it goes through the motherboard, which is not the way to do the job right.

If you need only one or two baud rate signals, the easier way is to substitute it for something you are not using. For instance, very few of us use 150 or 600 baud. If you need 9600 baud, break the land from the MC14411 pin 8 to the 74L04 buffer and substitute pin 1 instead.

Now the 9600 baud signal is being buffered and is traveling to the serial interface along the 150-baud line. No jumpers on the motherboard are needed, and on the serial board you simply jumper to the 150-baud pad, which has 9600 baud instead. This also leaves the UD lines for some other purpose.

New Motherboard

Have you noticed that SWTP is now using a new motherboard, the MP-B2? It features some interesting changes that may be indicative of things to come.

The motherboard basically has some buffering for the data bus on its way to and from the I/O boards and also has the address decoder for the eight I/O ports. This decoding is where the changes are.

As you know, port 0 is addresses 8000-8003; port 1 is 8004-8007, and so on. But actually, the address decoding is not completely done, and so each port really has a whole batch of addresses. For instance, port 0 is also 8040-8043 and 8080-8083, and so on. On the old MP-8 motherboard, all the locations from 8000 to 9FFF were used up for the I/O ports. This took up a full 8K of memory space.

The new MP-B2 board releases the space from 9000 to 9FFF and uses up only 8000-8FFF for I/O. Within that space, there is still much duplication, but now only 4K of memory is used up. This means that you could now add a 4K memory board from 9000-9FFF, which could not be done with the old motherboard.

If you have the older MP-B motherboard, you can make the change by breaking a PC land and adding a jumper. On this board, pin 5 of IC3 is grounded. This is an enable pin that must be low to permit I/O. If you break this ground connection and instead connect this pin to address bit A12, then this bit must be a 0 for the I/O to work. This will happen on addresses starting with an 8 (or 1000 in binary) but not on addresses starting with a 9 (1001).

But the new motherboard has other interesting changes as well. It has several extra unused pads on its address lines; it is designed so that some time in the future you can cut a few lands, put in some jumpers and move the I/O out of 8000 altogether up into high memory.

This is a change that's being contemplated for some time next year when the new Motorola 6809 processor is available. This will be a 16-bit processor that will still have an external 8-bit bus but will have 16-bit internal operations. I have been told by SWTP that they plan to offer an updated CPU board for older systems to allow us all to switch. Of course, that will involve some new software as well.

When all the software is being changed, it will be a good idea to make some other improvements at the same time, such as adding a new monitor, new monitor addresses and new I/O addresses.

One of the changes being considered is to move I/O up into the high addresses and open up the entire space from address 0000 up through BFFF for memory. This *would allow* a total of 48K of contiguous memory, up from the present 32K. This seems to be one reason for the new motherboard design — just plain planning ahead. These updates will probably be possible for older boards as well, but they may be a lot messier to implement.

There will be some more hints, as well as reviews of some of the equipment I have run across and used, in my next article on the SWTP system. ■

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PET User Port Cookbook

This is a sneak preview of part of The PET Manual *by author/publisher Greg Yob. Greg is taking pre-publication orders now and says the book will go into printing on April Fool's Day.*

Note: Pre-publication orders for The PET Manual *are $16, plus $2 for shipping, and can be sent to Mind's Eye Software, PO Box 354, Palo Alto CA 94302. No checks will be cashed until the book is printed; price will increase after printing.*

The PET personal computer has several expansion capabilities, including one known as the *user port*. This is a set of eight bidirectional lines and two handshake lines intended as a parallel port for the hobbyist to use in his experimental projects. Commodore has not released much information regarding the user port, and the object of this article is to explain the user port and its use.

Fig. 1 shows the location of the user port on the back of the PET and the pin-out of the PC edge. If you do not have a 12-position, 24-contact edge connector, use a larger one and cut it off to the 12-position size. If you do this, be sure to insert a polarization key in your connector; I found that it was easy to misalign a sawed-off connector with the PC edge, causing various mysterious glitches. Also, be sure that the top and bottom connections are really separate—the upper edge has a variety of signals that will interfere with the correct operation of the user port.

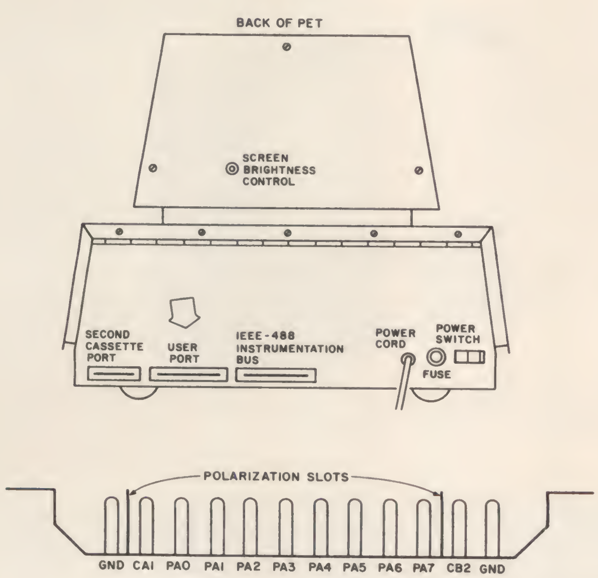

Fig. 1. The user port—location and pin-out. The user port pin-out as seen from the top. The user port pins are on the bottom of the PC card edge. The pins on top carry a variety of signals that are not related to the user port. Electrically, the lines correspond to one TTL source or load, depending on whether the line is in output or input mode. Use buffering or short cables if high data rates are required. The CB2 line does not have a pull-up resistor, so you may have to provide one if you are using CB2 in input mode.

The pin designations correspond to those on a MOS 6522 VIA (Versatile Interface Adapter), which is a complex LSI I/O chip produced by MOS Technology. (Write MOS Technology, 950 Rittenhouse Road, Norristown PA 19401, for the specification sheet.) The user port is connected directly to the VIA within the PET, and the lines are capable of sourcing or sinking *one* TTL load. If your application calls for a high data rate, note that your cables should be short or some buffering will be required.

As with all of the 650X microcomputer systems, the input and output appear to the microprocessor as a group of memory locations. PET's BASIC does not have any PRINT or INPUT statements for the user port, which requires you to use the PEEK and POKE statements. This also places another limitation, that is, BASIC's speed, which limits I/O through the user port to around 50 characters per second. If you want to use a more rapid rate, you must use machine language.

Since this article is concerned with the mechanics of using the user port, most of the examples will be in BASIC. Table 1 shows the memory locations for the 6522 in the PET.

At this point I must warn you: all of the other VIA lines are used within the PET for internal uses. If you fail to restore the VIA to its original state when you are finished, you will find that the PET behaves strangely, especially when dealing with the tape drives.

When I wrote the program for display of the VIA registers (which you will see later on), I didn't save it until I had it debugged. The PET wouldn't verify or even find the copy I had tried to save, and after handwriting the program, I realized the next morning that the VIA registers were not in their original states. Fortunately I had left the PET on overnight, and when I restored the registers, I was able to save the program.

The Blinkin' Lights Machine

For experimentation with the user port it is convenient to build a miniature "front panel" to indicate the state of each line and to control the lines via manual switches. A breadboard and some $20 worth of parts (bought at the local costly retail outlet) provided a handy "Blinkin' Lights Machine" that hooked to the user port and used the +5 volt supply from the second cassette drive.

```
 10  REM SIMPLE OUTPUT EXAMPLE
 20  REM SET DATA DIRECTION REGISTER TO OUTPUT
 30  POKE 59459,255
 40  REM COUNT FROM 0 TO 255
 50  FOR J=0 TO 255
 60  REM POKE TO OUTPUT REGISTER
 70  POKE 59471,J
 80  NEXT J
 90  REM DO IT AGAIN
100  GOTO 50
```

Example 1. Simple output example for user port.

Name	Address(hex)	Address(decimal)	Function
ORB	E840	59456	## (internal to PET)
ORA	E841	59457	Data with Handshake
PDRB	E842	59458	##
DDRA	E843	59459	Data Direction
T1L-W	E844	59460	##
T1C-H	E845	59461	##
T1L-L	E846	59462	##
T1L-H	E847	59463	##
T2L-W	E848	59464	##
T2C-H	E849	59465	##
SR	E84A	59466	Shift Register
ACR	E84B	59467	Auxiliary Control
PCR	E84C	59468	Peripheral Control
IFR	E84D	59469	Interrupt Flags
IER	E84E	59470	Interrupt Enable
ORA	E84F	59471	Data (no handshake)

Table 1. PET VIA register addresses. The named registers may be used to work with the user port. Some of the settings used may disable other PET functions, such as tape I/O, so you should restore the original settings when you are done. The registers with "##" in the Function column are used internally by the PET. If you are bold, there are two other I/O chips in the PET. These are MOS 6520s, with one starting at $E810 (59408) for internal uses and one at $E820 (59425) for the IEEE-844 bus.

Note that the circuit draws 200 mA, which is close to the maximum you can steal from the PET. If you have other PET extensions that use the PET supply, power the Blinkin' Lights externally.

Fig. 2 shows the circuit for the Blinkin' Lights Machine. The extra inverter and capacitor on the CB2 line are for an audio output to attach to your hi-fi set for some simple music making. One of the best ways to build this device is on a Vector breadboard, which has the fingers for an edge connector. This permits putting the Blinkin' Lights in series with a device under test to help with debugging the interface software and hardware.

Most of the examples shown below make use of the Blinkin' Lights Machine, so building *one might* be handy.

```
10  POKE 59459,255
20  K=1
30  POKE 59471,K
40  FOR J=1 TO 200 : NEXT
50  K=K*2
60  IF K=256 THEN 20
70  GOTO 30
```

Example 2. Another simple output example.

Simple Output

The simplest thing to do is output bytes to the user port. To do this, you must first set the Data Direction register to 255 (all bits set) and then set the Output register to the byte(s) that are to be output. Example 1 is a short program that counts from 0 to 255 and outputs the count to the user port.

The Data Direction register controls the PA0 through PA7 lines' data direction. If the bit is set for a given line (i.e., bit 0 is for line PA0), the line will be an output. If the bit is zero, the line will be an input.

When the PET is turned on with the Blinkin' Lights attached, all the LEDs will be lit. The PA0-PA7 lines are initially set for input, and the Blinkin' Lights will see lines in the high-impedance state as "high" (pulled up by the 7404s), turning on the LED for the line.

When the program (Example 1) is RUN, the data lines show that a binary count appears, which cycles through about once every three seconds. To slow the rate down so that the least significant bits (PA0 and PA1) will change state, add:

```
65  FOR K=1 TO 50 : NEXT
```

This will slow the counting loop down to around 10 Hz.

To see the effect of changing the Data Direction register, change line 30 to:

```
30  POKE 59459,15
```

Now the lines PA0-PA3 will count, and lines PA4-PA7 will remain lit (recall that an unconnected line will float to high with the Blinkin' Lights).

Example 2 shows another short program. Try it and see what it does! Note that in PET BASIC the NEXT statement may omit the loop counter if the innermost loop is being terminated. Another diversion is to change the program in Example 2.

```
20  K=1 : L=128
30  POKE 59471, K OR L
50  K=K*2 : L=L/2
```

(Just change these lines and let the others remain the same.)

Simple Input

To see simple input, POKE the Data Direction register to input mode and connect the switches to the PA0-7 lines. Note that the Blinkin' Lights has some DIP switches to isolate the manual switches from the data lines. This is because if they were always tied in, the switch setting would force the line to the switch's state.

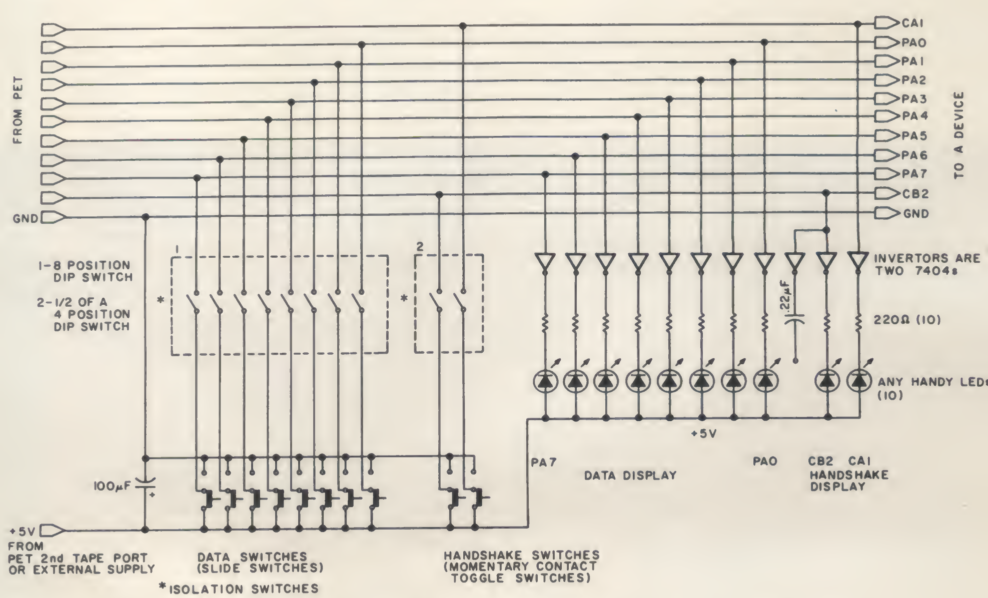

Fig. 2. Blinkin' Lights—PET user port switch register and indicator.

Shown	What It Represents
b	SPACE character (when not clear)
[..]	A lowercase character in a square box represents the corresponding graphics character. For example, [a] is the spade graphics character, or SHIFT-A:
Ⓒ	Clear Screen
Ⓗ	Home Cursor
Ⓤ	Cursor Up
Ⓓ	Cursor Down
Ⓡ	Cursor Right
Ⓛ	Cursor Left
Ⓘ	INST key
Ⓓ	DEL key

Table 2. PET program listing special characters.

Data Register	DATA	59471
Data Register, Handshake	HDATA	59457
Peripheral Control Register	PCR	59468
Auxiliary Control Register	ACR	59467
Interrupt Flag Register	IFR	59469

Table 3.

Then, PEEK the Data register and display the result on the PET display screen in a loop. As you change the switches, the number displayed will change. Example 3 is a program that does this. (Note: Table 2 shows how this article represents PET listings.) Line 70 homes the cursor and prints the value of the Data register. It then prints a CURSOR LEFT and three blanks. The reason for the CURSOR LEFT is that the PET has an oddity when it prints numbers onto the screen. When a number is printed, the format is: (SPACE or +)(Digits of Number)(CURSOR RIGHT).

When a short number is printed over a longer one, the printing stops after the CURSOR RIGHT. It is necessary to erase the old numbers with some blanks, so the cursor is moved left once and three blanks are printed. This prevents spurious numbers, such as "328," appearing on the display. (Try it, you won't like it!)

RUN this program and try the manual switches one at a time. You should see the sequence 0, 1, 2, 4, 8 . . . 128 appear on the PET screen.

If you set all the manual switches to zero and disconnect one of them with the DIP switch, the line will go high and the PET will see the bit as set. Be careful of this when you are using the Blinkin' Lights for debugging.

Joysticks

A simple and enjoyable way to use the user port is to attach a switch-operated pair of joysticks to your PET. Each joystick has four switches—one for each direction—that are closed when the stick is pointed that way. Fig. 3 shows a joystick circuit.

The program in Example 4 sets up the screen with a solid and hollow ball. Each joystick controls one of the balls, and both balls may be in motion at the same time. The switches and bit settings are the same as in Fig. 3.

Lines 170 and 180 clear the screen and print the character for the right and left joysticks. The PEEK sets the cursors (C1 and C2) to the value needed for use by POKE later. The value 32768 is the first address in memory in the display, which occupies memory locations 32768 to 33767.

```
10   REM SIMPLE INPUT EXAMPLE
20   REM SET DATA DIRECTION TO INPUT
30   POKE 59459,0
40   REM CLEAR SCREEN
50   PRINT " Ⓒ ";
60   REM PEEK DATA REGISTER & SHOW IT
70   PRINT" Ⓗ "PEEK(59471)" Ⓛ bbb";
80   REM DO IT AGAIN
90   GOTO 70
```

Example 3. Simple input example for user port.

Line 260 fetches the data from the user port. Since the joysticks ground the lines to indicate switch closures, the byte is complemented. It is then ANDed with 255 to return to eight bits, as the integer operations of the PET are 2's complement for 16 bits.

In Line 2010, the value for Z must be shifted right by four bits. This is done by dividing by 16 and truncating.

Lines 3020 and 3140 place a blank and the cursor, respectively, on the screen. The multiplication by 40 for Y is because the PET screen is 40 characters wide. If you delete line 3020, the motions of the joysticks will leave trails and let you draw pictures.

Transferring Data with Handshakes

The CA1 and CB2 lines permit data transfer with full handshaking for input and output. The 6522 VIA has a variety of options, and these are controlled by the registers in Table 3. In the 6522, the Peripheral Control register and the Auxiliary Control register select the various options for the operational modes for the VIA. Some of these bits affect the CA1 and CB2 lines and will be described in detail later.

The Interrupt Flag register has bits for the detection of several conditions that may be used for interrupts. In the PET, the use of the interrupts is a hazardous affair, as the PET has a 60 Hz internal interrupt, which handles various housekeeping tasks such as scanning the keyboard and maintaining the internal clock. Since these functions can only be handled in machine language, this article will not discuss how to handle the Interrupt Enable register.

To detect a condition, such as the transition of the CA1 line, PEEK the Interrupt Flag register and AND for the desired bit. The bit in the Flag register will remain set until other actions are taken, usually the reading or writing of data through the Data Handshake register.

If the above sounds confusing, that is because it *is* confusing, and with this in mind, you should attempt the examples in the following sections when you try to use the PET user port.

Using CA1

The CA1 line is an input-only line usually used to detect the handshakes for data transfers. For example, if a device is send-

```
5 REM BY GREGORY YOB, MAY 1978
10 REM DUAL CURSORS FOR JOY-STICKS
20 REM ATTACHED TO USER PORT WITH
30 REM BITS AS FOLLOWS:
40 REM LINE GROUNDED MEANS SWITCH IS
50 REM CLOSED AND TO MOVE CURSOR
60 REM  BIT 7 = LEFT STICK  UP
70 REM   "  6 =             DOWN
80 REM   "  5 =            RIGHT
90 REM   "  4 =             LEFT
100 REM  "  3 = RIGHT STICK UP
110 REM  "  2 =             DOWN
120 REM  "  1 =            RIGHT
130 REM  "  0 =             LEFT
140 REM DISPLAY IS WRAPAROUND
150 REM
160 REM PUT YOUR OWN CURSORS HERE
170 PRINT"Ⓒ [q]";:C1=PEEK(32768)
180 PRINT"Ⓒ [w]";:C2=PEEK(32768)
190 REM INITIALIZE SCREEN & POSITIONS
200 PRINT"Ⓒ";
210 X1=4:Y1=12:X2=35:Y2=12
220 POKE 33252,C1:POKE 33283,C2
230 REM SET UP DATA DIRECTION REG
240 POKE 59459,0
250 REM LOOK AT PORT
260 P=NOT(PEEK(59471))AND 255
270 REM CHECK RIGHT & LEFT
280 IF P AND 15 THEN GOSUB 1000
290 IF P AND 240 THEN GOSUB 2000
300 GOTO 260
500 REM ROUTINES 1000 & 2000 SET UP
510 REM X,Y = POSITION
520 REM Z = SWITCH SETTINGS
530 REM C = CURSOR CHARACTER
540 REM FOR ROUTINE 3000 WHICH
550 REM DOES MOVING & WRAPAROUND
560 REM
1000 REM RIGHT STICK
1010 X=X1:Y=Y1:Z=P AND 15:C=C1
1020 GOSUB 3000
1030 X1=X:Y1=Y:RETURN
2000 REM LEFT STICK
2010 X=X2:Y=Y2:Z=INT((P AND 240)/16)
2020 C=C2:GOSUB 3000
2030 X2=X:Y2=Y:RETURN
2500 REM
3000 REM MOVE CURSOR
3010 REM ERASE OLD ONE
3020 POKE 32768+40*Y+X,32
3030 REM FIND NEW POSITION
3040 IF Z AND 8 THEN Y=Y-1
3050 IF Z AND 4 THEN Y=Y+1
3060 IF Z AND 2 THEN X=X+1
3070 IF Z AND 1 THEN X=X-1
3080 REM WRAPAROUND CHECK
3090 IF X >39 THEN X=0
3100 IF X<0  THEN X=39
3110 IF Y >24 THEN Y=0
3120 IF Y<0  THEN Y=24
3130 REM POKE IN NEW CURSOR
3140 POKE 32768+40*Y+X,C
3150 RETURN
```

Example 4. Program to move two cursors with the joysticks in Fig. 3.

ing data to the PET, the CA1 line will be used to say that the data is now valid. If the PET is sending data, the CA1 line is used by the device to signal that it is ready for the data.

Using the CA1 line involves these steps:

1. Select the options you want and POKE the Peripheral Control register (PCR) and Auxiliary Control register (ACR) accordingly.
2. In a loop, check the CA1 Flag bit in the Interrupt Flag register (IFR) until it is set.
3. PEEK or POKE the HDATA (Data with Handshake) register with the data. This will reset the CA1 bit in the IFR.

Your options are as follows:

1. *Positive or negative transition*. CA1 will set its flag bit when the line goes high or low, depending on bit 1 in the PCR.

For a *negative* transition, use:

```
POKE (59468), PEEK(59468)AND 254
```

This is the value the PET initializes to when it is powered up. The reason it uses a PEEK instead of just POKEing to a 1 is that the other bits in the PCR should not be changed because they control other things.

For a *positive* transition, use:

```
POKE (59468), PEEK(59468)OR 1
```

2. *Latching of the input data*. If the input data is latched, the values present on the data lines will be latched when the CA1 line makes the correct transition. If the data is not latched, the values in the HDATA register will change as the data lines change. It is safest to use the latched mode when handshaking your data.

To enable latching, use this statement:

```
POKE (59467), PEEK(59467)OR 1
```

To disable latching, use:

```
POKE (59467), PEEK(59467) AND 254
```

To detect the Flag bit in the IFR, use a statement of the form:

```
IF PEEK(59469)AND 2 THEN ———
```

or

```
WAIT 59469,2
```

If you use the WAIT statement, note that the STOP key will be ignored by the PET, which means you must be *sure* that the CA1 line will make a transition—otherwise your PET will be hung up. For debugging, use the IF-THEN form. For reading or writing the HDATA register use:

```
PEEK (59457)
```

or

```
POKE 59457, ———
```

At last it is time for some examples. First, let's try counting from 0 to 255, with a wait for the CA1 line to be toggled before the next value is sent to the user port. Enter the program in Example 5, recalling Example 1.

When this program is run, the data lights will go out and will stay out until the CA1 switch is toggled. (If it doesn't, be sure that your DIP swich has been closed for CA1.) The first light (PA0) will then light, and as you toggle the CA1 swich, the Blinkin' Lights will count in binary.

Two things should be noted. First, the bounce of the CA1 switch will guarantee that *both* transitions occur, so the setting of the transition bit doesn't matter. Also, the speed of BASIC is slow enough that the bounce of CA1 doesn't cause double or more rapid counts. (If you try the equivalent program in machine language, your CA1 will count 10 to 25 times each time you flick the switch unless you have debounced it.)

Second, you can shorten your program by using the inverse condition in line 110, eliminating line 120:

```
110  IF(PEEK(59469)AND 2) = 0 THEN 110
```

Beware of the precedence of operators. If you tried:

```
110  IF PEEK(59469) AND 2 = 0 THEN 110
```

your lights would have counted up ignoring the CA1 line. The reason for this is that the operator = is evaluated *before* AND is. So, the sub-expression 2 = 0 is evaluated, giving a −1, which is ANDed with the IFR with the result that *any* bit will make the relation true. In this case, no other bits are set; the program then thinks that the CA1 line had toggled; and it drops through the loop.

Try it out—this error is quite common, and that's the reason

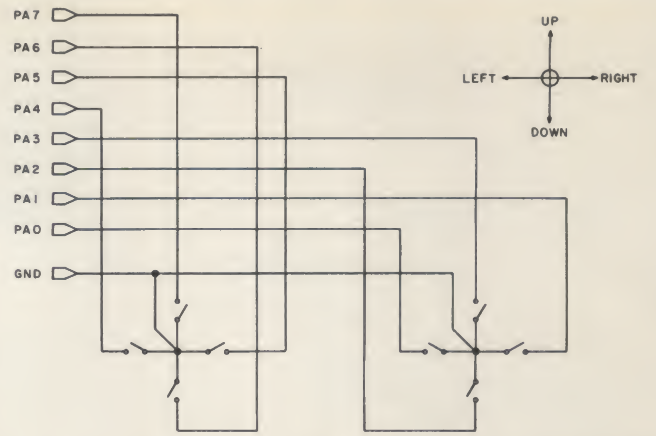

Fig. 3a. Joysticks for the PET. The switch arrangement for my PET joysticks is shown here. The switches are normally open.

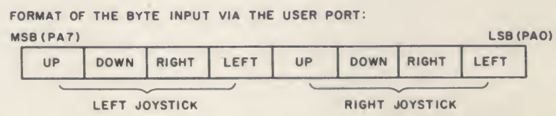

Fig. 3b. The byte input from the user port is shown here. This design exploits the fact that the PET lines PA0 to PA7 will float to high when they are disconnected. When a line goes low, the corresponding switch is closed.

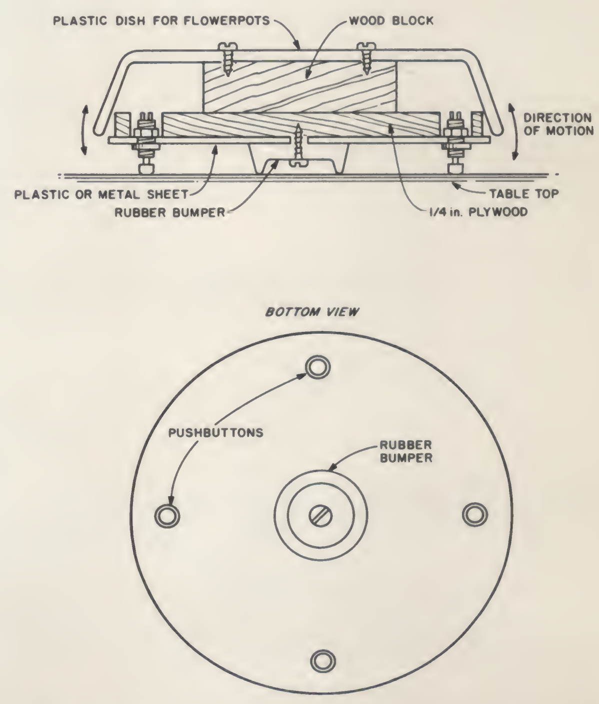

Fig. 3c. The Wobbilator—a low-cost alternative to joysticks that is easier to use as well. Eight low-cost miniature push buttons are used to build two of these units. Either normally open or normally closed push buttons may be used. (If normally closed, change lines 260 in Example 4 accordingly.) The push buttons should not be "snap action" or "detent" or go "click" when depressed, and should only move about 1/8 inch for closure. Use a bit of ribbon cable to attach the connector for the user port to the Wobbilators. Mark each Wobbilator with a dot for "Up" and "Right" and "Left." Choose a dish that fits your hand comfortably.

```
10   REM SIMPLE OUTPUT WITH HANDSHAKE
20   REM SET DDR TO OUTPUT
30   POKE 59459,255
40   REM SET POSITIVE TRANSITION FOR CA1
50   POKE 59468,PEEK(59468)OR 1
60   REM COUNT 0 TO 255
70   FOR J=0 TO 255
80   REM OUTPUT TO PORT
90   POKE 59457,J
100  REM WAIT FOR FLAG BIT
110  IF PEEK(59469)AND 2 THEN 130
120  GOTO 110
130  NEXT J
140  REM DO IT AGAIN
150  GOTO 70
```

Example 5. Simple output with handshake for PET user port. This program waits for a strobe on CA1 before sending the data from the PET.

```
10   REM SIMPLE INPUT VIA HANDSHAKE
20   REM DDR TO INPUT
30   POKE 59459,0
40   REM NEGATIVE CA1 TRANSITION
50   POKE 59468,PEEK(59468)AND 254
60   REM CLEAR SCREEN
70   PRINT" Ⓒ ";
80   REM WAIT FOR CA1
90   IF (PEEK(59469)AND 2)=0 THEN 90
100  REM FETCH DATA & DISPLAY
110  C=C+1
120  A=PEEK(59457)
130  PRINT" Ⓗ bbbbbbbbbbbbbbbbbbbbb Ⓗ ";
140  PRINT"COUNT"C"DATA"A
150  GOTO 90
```

Example 6. Simple input with handshake for PET user port. This program waits for a low on CA1 before accepting the data and then displays the decimal value of the data on the PET screen.

```
10   REM INPUT ASCII FROM KEYBOARD
20   REM CONVERT & DISPLAY ON SCREEN
30   GOSUB 1000: REM INITIALIZE
40   GOSUB 2000: REM GET CHAR AS A$
50   PRINT A$;
60   GOTO 40
1000 REM INITIALIZE PORT & TABLE
1010 POKE 59468,PEEK(59468)OR 1
1020 POKE 59467,PEEK(59467)OR 1
1030 DIM TB(31)
1040 FOR J=0 TO 31
1050 READ TB(J): NEXT J
1060 MD=0 : RETURN
1100 DATA 0,0,0,0,19,145,29,0,0,18,0,0
1110 DATA 0,13,0,146,0,147,0,157,0,20
1120 DATA 0,0,17,148,0,0,0,0,0,0
1130 REM
2000 REM FETCH CHAR & CONVERT
2010 IF(PEEK(59469)AND 2)=0 THEN 2010
2020 CH=PEEK(59457)AND 127
2030 REM TEST IF CTRL CHAR
2040 IF CH>31 THEN 2130
2050 REM MODE FLAG TESTS
2060 IF CH=10 THEN MD=0
2070 IF CH=27 THEN MD=128
2080 REM CONVERT VIA TABLE
2090 CH=TB(CH)
2100 IF CH=0 THEN 2010
2110 GOTO 2160
2120 REM CASE CONVERT
2130 IF CH>95 THEN CH=CH-32
2140 REM MODE CONVERT
2150 CH=CH OR MD
2160 A$=CHR$(CH): RETURN
```

Example 7. Input ASCII from keyboard, convert for all PET keys and display on PET screen. This program will accept the ASCII codes from the user port and follow the convention in Table 5 and in the text.

for this lengthy explanation. Be sure your expression is doing what you want it to, and if you aren't sure, use parentheses or try trial variations and print the results on your screen.

The next thing to try is entering a value on the data switches with the Blinkin' Lights and have the PET accept the data when the CA1 line is toggled. The program in Example 6 shows how.

When the program is run, you may set the switches to a value (be sure your DIP switches are closed or you will just get 255s), and when you toggle the CA1 switch, the count and value will appear at the top of the PET display. The count is used so you can tell when you reenter the same data value. Though the desired transition for CA1 is not important in this example, line 50 shows the opposite direction from the preceding output example. In line 140, the delimiter ";" is ignored because PET BASIC will permit this.

A Keyboard Via the User Port

As an example of a useful project for the user port, I interfaced an ASCII-encoded keyboard to the PET. Since I am a fair typist, the PET keyboard is frustrating for program entry and debugging. The following example is specific to my keyboard, but almost any full ASCII keyboard and most "Dumb Teletype" keyboards can be interfaced in a similar way.

The pin-out for the keyboard was determined and wired to the PET user port as shown in Table 4. Since the keyboard drew 500 mA, it was connected to a separate 5 volt supply.

At this point, the card edge on the Blinkin' Lights was very handy. The keyboard was connected to the Blinkin' Lights and the Blinkin' Lights *not* connected to the PET. Some investigation revealed that the keyboard did encode the parity bit and that it had a 2-key rollover.

The CA1 LED would turn on when a key was depressed and when a second key was depressed, it would flicker when the first key was released. This indicated that the strobe was a positive transition and that there was a 2-key rollover.

The keyboard was then attached to the PET, and the Simple Input via Handshake program (Example 6) was tried with line 50 changed to a positive CA1 transition. After a short warm-up, each keypress showed a value, and the rollover worked just fine.

Now that the keyboard was working electrically, a dilemma appeared: How can you emulate all the PET keyboard functions? A careful study of the PET keyboard, character set and cursor control functions reveals that there are 138 functions and that the ASCII code has only 128 characters in it.

The solution I chose (feel free to choose one of your own) was to let the control character represent the various nonprinting keys (cursor movements, RVS and so on) and to convert all other characters from the keyboard to uppercase. Since the high bit for a given PET character is set if the character is a graphics character, I decided to have a Mode flag—if you pressed ESCAPE, all further alphanumeric keys would show their graphics character, and when you pressed LINEFEED, the mode would be "normal," and the character would appear.

It should be noted that the PET character set is *not* ASCII but is similar to ASCII. This resulted in some further translation steps, and the entire conversion routine used these steps:

1. Get the character from the user port and remove the Parity bit.
2. If it was a control character (0 to 31), do the following:
   (a) Find a value in a 32-element translation array for the correct PET character.
   (b) If the table value is zero, ignore and go to step 1.
   (c) Print the character on the screen and go to step 1.
3. If the character is in the range 96 to 127, subtract 32. (Converts lowercase to uppercase.)
4. If the Mode flag is set (for graphics), OR with 128 to set the highest bit.

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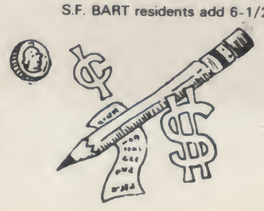

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✓ Reader Service—see page 179

5. Print the character on the PET.

6. Go to step 1.

Note: in step 2, if the character was an ESCAPE or a LINEFEED, the Mode flag would be set or reset, respectively, and the table entry for these characters would be a zero.

The next thing to do was to choose the meanings for the control characters. Some control characters, such as CTRL-M and CTRL-J, were already used for RETURN, LINEFEED, etc. Keys were chosen for their convenience on the keyboard in Table 5.

The appropriate PET character values were then placed in a 32-value table for lookup by the translating routine. A BASIC program was written to test this scheme out (see Example 7). Note that RETURN is the same value, 13, as the value fetching it (i.e., CH is 13 also). In line 2020, the masking is done to remove parity when the character is read from the user port. The Mode flag is set to 0 or 128, which permits the use of OR in line 2150.

```
10 REM **** PET MACHINE CODE LOADER ****
20 REM BY GREGORY YOB, 1978
30 REM READS DATA STRINGS IN FORMAT
40 REM IDENTICAL TO PET MONITOR AND
50 REM LOADS INTO INDICATED MEMORY
60 REM LOCATIONS. FIRST NUMBER IS
70 REM START ADDRESS, NEXT 8 VALUES
80 REM ARE BYTES TO LOAD.
90 REM   IF A BYTE IS 'XX' IT WILL NOT
100 REM BE LOADED, AND MEMORY CELL WILL
110 REM BE UNCHANGED, AND NEXT BYTE
120 REM LOADED INTO NEXT CELL.
130 REM IF A BYTE IS '**' OR AN ADDRESS
140 REM IS '****', THE LOAD WILL STOP.
150 REM LINE 20000 GUARANTEES END IF
160 REM '**' OR '****' IS NOT FOUND.
170 REM
180 REM NOTE: THIS PGM MORE USEFUL IF
190 REM EXTENDED TO DATA TAPE FILES.
200 REM
300 PRINT"Ⓒ bPET LOADER PROGRAM"
310 READ A$: IF A$="END" THEN 950
315 PRINT" ⒹⒹ "A$"Ⓓ"
320 GOSUB 400 : REM GET ADDR
330 IF ADDR <0 THEN 950
340 FOR B = 1 TO 8
350 GOSUB 500 : REM GET BYTE
355 IF BYTE = -2 THEN 380
360 IF BYTE < 0 THEN 950
370 POKE ADDR,BYTE : REM DO THE DEED
375 PRINT ADDR;TAB(10);BYTE
380 ADDR=ADDR+1 : NEXT B
390 GOTO 310
400 REM ** PARSE ADDRESS **
410 B$=MID$(A$,1,4)
420 IF B$="****" THEN ADDR=-1 :RETURN
430 GOSUB 600 : REM HEX CONVERTER
440 ADDR=HEX
450 RETURN
500 REM ** PARSE BYTES **
510 B$=MID$(A$,B*3+3,2)
520 IF B$="XX" THEN BYTE=-2 :RETURN
530 IF B$="**" THEN BYTE=-1 :RETURN
540 GOSUB 600 : REM HEX CONVERTER
550 BYTE =HEX
560 RETURN
600 REM HEX CONVERTER
610 HEX=0
620 FOR H=1 TO LEN(B$)
630 H$=MID$(B$,H,1)
640 IF H$ <"Ø" THEN 900        ("Ø" is zero)
650 IF H$ >"F" THEN 900
660 IF H$ <":" THEN 700
670 IF H$ <"A" THEN 900
680 D=ASC(H$)-55 : GOTO 710
700 D=ASC(H$)-48
710 HEX=HEX*16 + D
720 NEXT H
730 RETURN
900 PRINT"ⒹⒹ #### BAD VALUE IN DATA ####"
910 PRINT"Ⓓ LOAD ABORTED":END
950 PRINT"ⒹⒹ LOAD FINISHED":END
1000 DATA"0338 XX XX 78 A9 75 8D 19 02"      (Note: all 0
1010 DATA"0340 A9 03 8D 1A 02 A9 00 8D"        are zeroes)
1020 DATA"0348 43 E8 8D C7 03 AD 4C E8"
1030 DATA"0350 09 01 8D 4C E8 AD 4B E8"
1040 DATA"0358 09 01 8D 4B E8 58 60 78"
1050 DATA"0360 A9 85 8D 19 02 A9 E6 8D"
1060 DATA"0368 1A 02 58 60 A9 00 48 48"
1070 DATA"0370 48 48 4C 85 E6 AD 4D E8"
1080 DATA"0378 29 02 D0 07 20 6C 03 EA"
1090 DATA"0380 4C 7E E6 AD 41 E8 29 7F"
1100 DATA"0388 C9 1F 10 30 C9 0A D0 07"
1110 DATA"0390 A9 00 8D C7 03 F0 E5 C9"
1120 DATA"0398 1B D0 07 A9 80 8D C7 03"
1130 DATA"03A0 D0 DA AA BD C8 03 F0 D4"
1140 DATA"03A8 EA AE 0D 02 9D 0F 02 E8"
1150 DATA"03B0 E0 0A D0 02 A2 00 8E 0D"
1160 DATA"03B8 02 4C 7C 03 C9 60 30 02"
1170 DATA"03C0 E9 20 0D C7 03 D0 E2 00"
1180 DATA"03C8 00 00 00 00 13 91 1D 00"
1190 DATA"03D0 00 12 00 00 00 0D 00 92"
1200 DATA"03D8 00 93 00 9D 00 14 00 00"
1210 DATA"03E0 11 94 00 00 00 00 00 00"
1220 DATA"03E8 ** ** ** ** ** ** ** **"
20000 DATA"END"
```

Machine-Language Source

```
      ! FOOL THE PET INTO READING THE USER PORT AS THE
      ! COMMAND KEYBOARD IN PARALLEL WITH THE NORMAL
      ! KEYBOARD BY READING THE USER PORT WHEN THE 60 HZ
      ! INTERRUPT IS SERVICED.  IF A CHARACTER IS
      ! PRESENT, TRANSLATES ACCORDING TO SCHEME DESCRIBED
      ! IN USER PORT ARTICLE AND PUTS CHARACTER INTO
      ! THE PET INPUT BUFFER.
      !        THIS CODE TAKEN FROM AN IDEA BY RICHARD
      ! TOBEY. IMPLEMENTED BY GREGORY YOB.
      !
      ! *** INITIALIZATION CODE ***
      !        TURN OFF INTERRUPTS, AND SET THE PET
      ! "INTERRUPT VECTOR" TO POINT TO THE ACTIVE CODE.
      ! SET UP THE USER PORT TO READ THE KEYBOARD, AND
      ! SET THE MODE VARIABLE TO "CHARACTER MODE" (0)
      !
      ! NOTE*** THIS CODE RESIDES IN THE SECOND CASSETTE
      ! BUFFER ( 033A TO 03FF )
      !
033A  78        XON   SEI         ! DISABLE INTERRUPTS
033B  A9 75           LDA #$75    ! SET UP NEW
033D  8D 19 02        STA $0219   !    "INTERRUPT
```

Though this program is suitable for entering data into a BASIC program, the keyboard cannot be used in direct mode, that is, entering BASIC statements or LIST, etc. Example 8 shows a BASIC program which, when run, will load a machine-language program into the second cassette buffer. When this machine-language program is executed (by SYS(826)), the keyboard attached to the user port will operate "in parallel" with the PET keyboard. If you follow the cautions indicated in Example 8, you will be able to use the auxiliary keyboard for other programs, etc.

The first program, A BASIC Machine-Language Loader, will load any machine-language code in this format: AAAA HH HH HH HH HH HH HH HH. AAAA is the starting address for the first hexadecimal value, HH. Eight hexadecimal values are permitted per DATA string. Each string must begin with the address, and a space must separate the values.

If the characters in an HH field are "XX," the program will not load a value into the corresponding byte (skipping it). The characters "**" in an HH field, or "****" in an AAAA field, will end the load.

This data format (except "XX" and "**","****") is identical to the one used by the PET TIM monitor, so at a later time you can easily use the PET monitor to directly load this code from the DATA statements.

The DATA statements in this program contain the object code for the second command keyboard program described in the text. To start the machine program, enter SYS(826) and press RETURN. The PET tape I/O will not work while the machine code is running! Use SYS(863) to stop the machine code and make the tape I/O workable.

Input from the second keyboard follows the rules in Table 5 and as described in the text.

It is beyond the scope of this article to describe the details of the machine-language program. A source listing is provided in Example 8 for those who wish to puzzle it out.

A User Port Monitor Program

When you are attempting to interface to the user port, it is often necessary to write several small programs to set and display the VIA registers. The program in Example 9 performs these functions and will often

	Keyboard Pin	PET User Port
1	INT Key	—
2	RPT Key	—
3	No connection	CB2
4	No connection	—
5	GND	GND
6	+5 Volts (separate supply)	—
7	Strobe	CA1
8	Parity	PA7
9	Bit 4	PA3
10	Bit 3	PA2
11	Bit 1	PA0
12	Bit 7	PA6
13	Bit 2	PA1
14	Bit 6	PA5
15	Bit 5	PA4

Table 4. ASCII keyboard to PET user port wiring list. Your keyboard will, no doubt, have a different pin-out—just notice the data and handshake lines. If your keyboard requires an acknowledge, connect your ACK to CB2.

```
0340  A9 03               LDA #$03   !         VECTOR"
0342  8D 1A 02            STA $021A
      !
0345  A9 00               LDA #$00   ! SET UP USER PORT & MODE
0347  8D 43 E8            STA $E843  ! DATA DIRECTION REGISTER
034A  8D C7 03            STA MODE   ! MODE CELL
034D  AD 4C E8            LDA $E843  ! PERIPHERAL CONTROL REGISTER
0350  09 01               ORA #$01
0352  8D 4C E8            STA $E84C  ! PCR
0355  AD 4B E8            LDA $E84B  ! AUXILIARY CONTROL REGISTER
0358  09 01               ORA #$01
035A  8D 4B E8            STA $E84B  ! ACR
035D  58                  CLI        ! ENABLE INTERRUPTS
035E  60                  RTS        !  AND RETURN TO CALLER
      !
      ! *** RESTORATION CODE ***
      !        RESTORE THE "INTERRUPT VECTOR" SO THAT TAPE
      ! I/O CAN WORK PROPERLY.
      !
035F  78         XOFF     SEI        ! DISABLE INTERRUPTS
0360  A9 85               LDA #$85   ! SET UP OLD
0362  8D 19 02            STA $0219  !    "INTERRUPT
0365  A9 E6               LDA #$E6   !         VECTOR"
0367  8D 1A 02            STA $021A
036A  58                  CLI        ! ENABLE INTERRUPTS
036B  60                  RTS        !  AND RETURN TO CALLER
      ! *** STACK ADJUSTMENT ROUTINE ***
      !
036C  A9 00      STAX     LDA #$00   ! DUMMY PUSHES TO PET STACK FOR
036E  48                  PHA        ! CORRECT OPERATION OF THE
036F  48                  PHA        ! RESTORATION CODE
0370  48                  PHA
0371  48                  PHA
0372  4C 85 E6            JMP $E685  ! JUMP TO PET INTERRUPT HANDLER
                                     ! TO CONTINUE PROCESSING
      !
      ! *** ACTIVE CODE ***
      !        CHECKS USER PORT IFR FOR CHARACTER. IF NOT
      ! PRESENT, RETURNS TO PET INTERRUPT PROCESSOR.
      !        IF PRESENT, TRANSLATES ACCORDING TO SCHEME
      ! AND PUTS INTO THE INPUT BUFFER.
      !
0375  AD 4D E8   PCODE    LDA $E84D  ! INTERRUPT FLAGS REGISTER
0378  29 02               AND #$02
037A  D0 07               BNE KEYS   ! DETECTED CHARACTER
037C  20 6C 03   FINISH   JSR STAX   ! SET UP TO CALL THE
037F  EA                  NOP        ! PET RESTORATION CODE
0380  4C 7E E6            JMP $E67E  ! WHICH IS FROM HERE
      !
      !CHARACTER PROCESSING
      !
0383  AD 41 E8   KEYS     LDA $E841  ! ORA HANDSHAKE DATA REGISTER
0386  29 7F               AND #$7F   ! MASK OFF PARITY
0388  C9 1F               CMP #$1F
038A  10 30               BPL NCTR   ! IF POSITIVE, ISN'T A CONTROL CHAR
038C  C9 0A               CMP #$0A
038E  D0 07               BNE NLFD   ! CHAR ISN'T A LINEFEED
0390  A9 00               LDA #$00
0392  8D C7 03            STA MODE   ! SET MODE TO CHARACTERS
0395  F0 E5               BEQ FINISH ! BEQ SAVES A BYTE
      !
0397  C9 1B      NLFD     CMP #$1B   ! ESCAPE?
0399  D0 07               BNE CTRL   ! OTHER CTRL CHARS
039B  A9 80               LDA #$80   ! SET MODE TO
039D  8D C7 03            STA MODE   !      GRAPHICS
03A0  D0 DA               BNE FINISH ! SAVE ANOTHER BYTE
      !
      ! PROCESS CONTROL CHARS BY TABLE LOOKUP
      !
03A2  AA         CTRL     TAX
03A3  BD C8 03            LDA TABL, X
03A6  F0 D4               BEQ FINISH ! IGNORE IF TABLE RETURNS ZERO
03A8  EA                  NOP
      !
      ! *** STASH CHARACTER INTO INPUT BUFFER ***
      !        NOTE THAT BUFFER POINTER MUST BE CHECKED &
      ! CORRECTLY ADJUSTED.
      !
03A9  AE 0D 02   STASH    LDX $020D  ! PET INPUT BUFFER POINTER
03AC  9D 0F 02            STA $020F,X  ! BASE OF INDEX IS START OF BUFFER
03AF  E8                  INX
03B0  E0 0A               CPX #$0A   ! CHECK IF FULL
03B2  D0 02               BNE *+4    ! SHORT JUMP (SKIP ONE INSTR)
03B4  A2 00               LDX #$00
03B6  8E 0D 02            STX $020D  ! SAVE NEW POINTER
03B9  4C 7C 03            JMP FINISH ! I KNOW, I COULD HAVE SAVED A BYTE.
      !
03BC  C9 60      NCTRL    CMP #$60   ! CONVERT TO UPPER CASE
03BE  30 02               BMI NCASE
03C0  E9 20               SBC #$20
03C2  0D C7 03            ORA MODE   ! CONVERT TO GRAPHIC IF
03C5  D0 E2               BNE STASH  !  MODE > 0
      !
      ! *** DATA STORAGE AREA ***
      !
03C7  00         MODE     ! MODE BYTE = 0 IF CHARACTERS
                          !           128 IF GRAPHICS
03C8             TABL     ! CONTROL CHARACTERS CONVERSION TABLE
03C8                      .BYTE.  00,00,00,00,13,91,1D,00
03D0                      .BYTE.  00,12,00,00,00,0D,00,92
03D8                      .BYTE.  00,93,00,9D,00,14,00,00
03E0                      .BYTE.  11,94,00,00,00,00,00,00
      !
03E8  ! *** END OF CODE ***
```

Example 8. PET machine code program for a second command keyboard.

save some time and trouble.

Some comments concerning the code are in order:

Lines 70 to 90 hold the register names, which are similar to, and in the same order as, those in Fig. 2.

Line 210 puts a colon and some blanks at the end of each register name for display purposes.

Line 250 sets the Flags array to display *the most commonly* used registers when the program starts.

Notice the *three* blanks between the 4 and the 3 in line 310.

Line 320 moves the menu to a position that will not be overwritten when the program is displaying all 16 registers.

Cursor movements are used extensively to control the display. Be sure to count them carefully.

Lines 1000 to 1050 display a number in binary by moving a mask bit (variable Z1) to the right and printing the sign of the result (line 1030).

Subroutine 2000 is required to permit you to choose the time to access the Handshake Data register. The reason is that each access to this register will reset the Interrupt Flag bit. The D (DATA) command will read this register.

Subroutine 3000 lets you change the registers you want to see displayed. If you forget the names (I often do), enter a meaningless name, such as "XXX," and all the names will be shown.

Since the display is in binary, so is the input (see subroutine 4500).

Subroutine 4990 provides a "False Cursor," which is handy in many programs.

When the CB2 line is toggled, the original values of the PCR and ACR are saved, and after toggling, restored. CB2 is forced both high and low to guarantee a handshake pulse.

Using the User Port Monitor Program

After you have tried out the various commands and are familiar with them, attach the Blinkin' Lights to the user port and run the Monitor program. Close all of the Data Isolation switches and set the Data switches to low. If you are starting from a reset PET (you haven't changed any of the user port registers), the PET display will look like this:

		7	6	5	4	3	2	1	0
DDRA	:	0	0	0	0	0	0	0	0
ACR	:	0	0	0	0	0	0	0	0
PCR	:	0	0	0	0	1	1	0	0
IFR	:	0	1	1	0	0	0	0	0
DATA	:	0	0	0	0	0	0	0	0

D = DATA P = POKE S = SHOW
H = HELP Q = QUIT T = TOGGLE

The "1" bits are aspects of the registers used internally by the PET for its housekeeping functions. If you set the low

Character + CTRL	PET Function
Q	Clear Screen
D	Home Cursor
E	Cursor Up
S	Cursor Left
F	Cursor Right
X	Cursor Down
Y	INST
U	DEL
I	RVS on
O	RVS off

Table 5. Control characters for PET special keys.

```
10  REM CB2 BLINKER
20  POKE 59467, PEEK(59467) AND 227
30  POKE 59468,(PEEK(59468) AND 31) OR 192
40  FOR J = 1 TO 300 : NEXT
50  POKE 59468, PEEK(59468) OR 244
60  FOR J = 1 TO 300: NEXT
70  GOTO 30
```

Example 10. CB2 Blinker program. The CB2 LED in the Blinkin' Lights will blink at about 1Hz.

four bits on the Blinkin' Lights Data switches to high, the DATA: line will become 0 0 0 0 1 1 1 1. As you change the switch settings, you will notice that there is a lag of about one second before the display responds.

This illustrates how the Monitor program can show the data you input to the user port. Now disconnect the Data switches by opening the Data Isolation switches—the DATA: will now become all ones.

With the P command, change the DDRA to 1 1 1 1 1 1 1 1. The DATA: is now 0 0 0 0 0 0 0 0. This is the initial value stored in the PET. Using P again, change the DATA register to some other value and watch it appear on the LEDs on the Blinkin' Lights. This illustrates data output.

If you close the Data Isolation switches and change these registers with the P command, you can demonstrate input via handshake with the CA1 line:

DDRA	set to	0000 0000	
PCR	set to	0000 1100	(Negative transition)
ACR	set to	0000 0001	(Enable latching)

When you return to the display, the IFR may look like: 0 1 1 0 0 0 1 0. If it does, press D and then press any key. The IFR will now return to: 0 1 1 0 0 0 0 0, indicating that the Flag bit was reset when the Data with Handshake was read.

Set the Blinkin' Lights Data switches to some value and watch the DATA: on the display. The value will follow the switch settings. Now, flick the CA1 toggle switch (be sure the Isolation switch is closed), and the IFR will show bit 1 as set. If you now change the Data switches, the DATA: value will not change. It will remain latched until you do the D command. This illustrates input with latching and handshaking.

Feel free to experiment with other settings for the user port with the Monitor program.

The CB2 Line

The CB2 line is the most complex of the user port lines. It can be operated in a variety of modes, including the provision of an output handshake and the serial transfer of data. As most of the CB2 modes can only be controlled from machine language, this article will cover only the two modes that are usable from BASIC.

CB2 as an Output or Handshake

The CB2 line may be turned off or on directly to provide either a handshake line or a 9th output bit for the user port. In either case, the shift register modes must be disabled by setting the Auxiliary Control register (ACR) as follows:

```
POKE 59467, PEEK(59467) AND 227
```

(In most cases the ACR is already zero, so this may be ignored. However, safety first!)

```
10 REM 6522 VIA DISPLAY AND MONITOR
20 REM PROGRAM
30 REM BY: GREGORY YOB, 1978
40 REM SET UP R$= REGISTER NAMES,
50 REM A()=REGISTER ADDRESSES,
60 REM F()=SHOW REGISTER IF >0
70 DATA "ORB","ORA","DDRB","DDRA"
80 DATA "T1LC-L","T1C-H","T1L-L","T1L-H"
90 DATA "T2LC-L","T2C-H","SR","ACR"
100 DATA"PCR","IFR","IER","DATA"
110 REM 'DATA' IS ORA WITHOUT HANDSHAKE
120 DIM R$(16),A(16),F(16)
200 A=59456: FOR J=1 TO 16
210 READ A$:R$(J)=LEFT$(A$+"bbbbbbb",6)+";"
220 A(J)=A:A=A+1
230 NEXT J
240 REM SET FLAGS FOR INITIAL DISPLAY
250 F(4)=1:F(12)=1:F(13)=1:F(14)=1:F(16)=1
300 REM SET UP DISPLAY
310 PRINT"C bbbbbbbb7bb6bb5bb4bbb3bb2bb1bb0"
320 PRINT"DDDDDDDDDDDDDDDDD";
330 PRINT"D=DATA  P=POKE  S=SHOW"
340 PRINT"H=HELP  Q=QUIT  T=TOGGLE"
400 REM DISPLAY LOOP
410 PRINT"H D D ";
420 FOR J=1 TO 16
430 IF F(J)=0 THEN 450
440 Z=PEEK(A(J)):PRINTR$(J);:GOSUB1000
450 NEXT J
460 REM IF NO INPUT DO LOOP AGAIN
470 GETA$:IFA$=""THEN 410                ( "" is a null string)
500 REM DO COMMANDS
510 IF A$="D" THEN GOSUB 2000
520 IF A$="P" THEN GOSUB 2500
530 IF A$="S" THEN GOSUB 3500
540 IF A$="H" THEN GOSUB 3000
550 IF A$="T" THEN GOSUB 5500
560 IF A$="Q" THEN END
700 GOTO 310
1000 REM DISPLAY IN BINARY
1010 Z1=128
1020 FOR Z2=1 TO 8
1030 PRINT SGN(Z AND Z1);
1040 IF Z2=4 THEN PRINT "b";
1050 Z1=Z1/2 : NEXT Z2: PRINT : RETURN
2000 REM DISPLAY HANDSHAKE REGISTER
2010 Z = PEEK(59457) :PRINT"D"R$(2); GOSUB 1000
2020 PRINT"D"; : GOSUB 4990:RETURN
2500 PRINT"C POKE REGISTERHDD"
2510 GOSUB 4000
2520 GOSUB 4500
2530 POKE A(Z),B
2540 RETURN
3000 PRINT"C bb 6522 REGISTER DISPLAY AND CHANGE DD
3010 PRINT"THIS SHOWS THE VALUES FOR THE PET'S
3020 PRINT"VIA REGISTERS. YOU CAN LOOK AT ALL OF
3030 PRINT"THEM. THOSE USED FOR THE USER
3040 PRINT"PORT ARE SHOWN WHEN THE PROGRAM
3050 PRINT"STARTS. D LLL THE DISPLAY IS REFRESHED ABOUT ONCE
3060 PRINT"PER SECOND. PRESS A KEY TO DO A COMMAND
3070 PRINT"D bbbD=DATA  READS ORA WITH HANDSHAKE
3080 PRINT"   P=POKE  LETS YOU POKE A REGISTER
3090 PRINT"   S=SHOW  SELECTS REGISTERS TO DISPLAY
3100 PRINT"   Q=QUIT  STOPS PROGRAM
3110 PRINT"   T=TOGGLE  TURNS CB2 ON, THEN OFF TO
3120 PRINT"             FORCE HANDSHAKE & THEN
3130 PRINT"             RESTORES TO PRIOR STATE
3300 PRINT"DD";:GOSUB4990:RETURN
3500 REM CHANGE DISPLAYED REGISTERS
3510 PRINT"C SHOW REGISTERSDDD
3520 GOSUB 4000
3530 PRINT"S=SHOW,E=ERASE,X=FINISHED";:GOSUB 5000
3540 IF A$="S" THEN F(Z)=1
3550 IF A$="E" THEN F(Z)=0
3560 IF A$="X" THEN RETURN
3570 PRINT"HDDDD";
3580 GOTO 3520
4000 REM GET REGISTER NAME, RETURN Z=INDEX
4010 PRINT"DD REGISTER NAME:bbbbbbbbbbbbLLLLLLLLLLLL";
     :INPUT A$
4020 RESTORE:FORZ=1TO16:READB$
4030 IFB$=A$THEN RETURN
4040 NEXTZ:PRINT"DDD THE REGISTERS ARE CALLED:
4050 FOR J=1TO16:PRINT LEFT$(R$(J),6)"bbbb";:NEXT J
4060 PRINT"UUUUUUUUUUU";: GOTO 4010
4500 REM - GET BINARY NUMBER
4510 PRINT"BINARY VALUE: ";:INPUT A$:Z1=128:B=0
4520 IF LEN(A$) < 8 THEN PRINT "U";: GOTO 4510
4530 FOR J=1TO8
4540 IF MID$(A$,J,1)="1"THEN B=B OR Z1
4550 Z1=Z1/2:NEXT J
4560 RETURN
4990 PRINT"PRESS A KEY";
5000 GET A$: PRINT"&L";:FOR K=1 TO 20: NEXT K
5010 PRINT"bL";:FOR K = 1 TO 20: NEXT K
5020 IF A$=""THEN 5000                  ( "" is a null string)
5030 RETURN
5500 REM TOGGLE CB2
5510 A=PEEK(59467):B=PEEK(59468)
5520 C=B AND 131 OR 192
5530 D= B OR 224
5540 POKE 59468,C
5550 POKE 59468,D
5560 POKE 59468,B
5570 POKE 59467,A
5580 RETURN
```

Example 9. PET user port display and monitor program.

Then, the CB2 line is set high by:

POKE 59468, PEEK(59468) OR 224

and it is set low by:

POKE 59468,(PEEK(59468)AND 31) OR 192

The parentheses are required to ensure that the operations AND and OR are done correctly. Example 10 is a short "CB2 Blinker" that blinks CB2 at about 1 Hz.

Interfacing the Writehander

The Writehander is a one-handed input keyboard manufactured by the NewO Company, 246 Walter Hays Drive, Palo Alto CA 94303 (see *Kilobaud* No. 23, p. 9, for a description of the Writehander).

The Writehander is a gray plastic ball about six inches across with switches placed so that the fingers and thumb may touch them. By altering the finger arrangements, you can send any of the 128 ASCII codes to the computer. When the byte is ready, the Writehander provides a strobe and then requires an acknowledge signal before it sends the next byte.

The wiring to the PET user port is shown in Table 6. The grounds were connected together for the power supply, the PET and the Writehander. The Writehander has several jumper options that were wired as:

1) Strobe goes active low + to –
2) Acknowledge active low + to –
3) Parity (Bit 8) set low Gnd

This means that the following steps are required to talk with the Writehander.

1. Poke the DDR to all inputs
2. Set CA1 to detect the Hi to Low transition
3. Disable the CB2 Shift Register mode
4. Enable latching with CA1
5. Turn CB2 on (high)
6. Wait for the interrupt flag in the IFR
7. Read the Data with Handshake
8. Mask off the parity bit and display the data (or whatever)
9. Turn CB2 off (low)
10. Go to step 5

These steps were incorporated into a program, Example 11, which was only intended to accept characters from the Writehander and display their values on the PET screen. See the program in Example 7 for a more complete processing of the characters. (If you are a real diehard, modify the assembly program in Example 8 to provide the required CB2 logic.)

Lines 30 and 40 can be combined, but this program keeps them separate to show the different things being done. If you want to show the character rather than the value, use:

```
90 PRINT CHR$( X AND 127 );
```

I encountered several frustrating experiences during the development of the above (simple!) program:

1. The Writehander would work perfectly when attached to the Blinkin' Lights by itself, and the program would work perfectly when it was attached to the Blinkin' Lights . . . and (guess), when the Writehander was attached to the PET, it *wouldn't* work! After much fiddling, I discovered that the Writehander required that the ACK (CB2) be *high* before it would bring the Strobe (CA1) low. Thus CB2 had to be set high before trying to look for a character.

2. The parenthesis around the PEEK in line 80 is required for the CB2 to be set low due to the precedence relations of AND and OR.

3. PET ASCII isn't ASCII, so the "wrong" character would be displayed (see A Keyboard Via the User Port section for a detailed discussion).

```
5 PRINT" © ";
10 POKE 59459,0
20 POKE 59468, PEEK(59468) AND 254
30 POKE 59467, PEEK(59467) AND 227
40 POKE 59467, PEEK(59467) OR 1
50 POKE 59468, PEEK(59468) OR 224
60 IF (PEEK(59469) AND 2) = 0 THEN 60
70 X = PEEK(59457)
80 POKE 59468, (PEEK(59468)AND 31) OR 192
90 PRINT X AND 127;
100 GOTO 50
```

Example 11. Writehander input program.

CB2 as a Shift Register

The CB2 line may be made to act as a shift register by setting a combination of bits 2, 3 and 4 in the Auxiliary Control register (ACR). Only one of these modes is usable from BASIC. The others require the use of machine language to be controlled properly (see the 6522 VIA specification for details).

One nice way to experiment with this is to use the PET to make "square wave music." Fig. 4 shows two ways to attach an audio extension to the PET. Each of these simply uses the CB2 line for the audio signal.

Checking It Out

Once you have your audio extension together, one way to check it out is to toggle CB2 in Handshake mode as fast as BASIC will go:

```
10 POKE 59467,PEEK(59467)AND 227
20 A = 59468: X = PEEK(A)AND 131 OR 192
30 Y = PEEK(A) OR 224
```

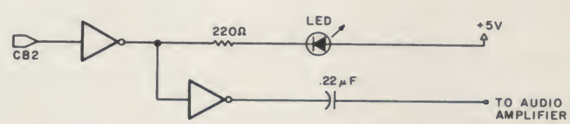

Fig. 4a. Add the inverter and capacitor to the output of the CB2 inverter in the Blinkin' Lights. Fig. 2 has this addition indicated.

Line	Color	Function	PET
1	Brown	Bit 1	PA0
2	Red	+7 to +23 V power (unused)	
3	Orange	Bit 2	PA1
4	Yellow	Ground	GND
5	Green	Bit 3	PA2
6	Blue	+5 V (separate power supply)	
7	Violet	Bit 4	PA3
8	Gray	—	
9	White	Bit 5	PA4
10	Black	—	
11	Brown	Bit 6	PA5
12	Red	—	
13	Orange	Bit 7	PA6
14	Yellow	Strobe	CA1
15	Green	Bit 8	PA7
16	Blue	Acknowledge(ACK)	CB2

Table 6. Writehander wiring list.

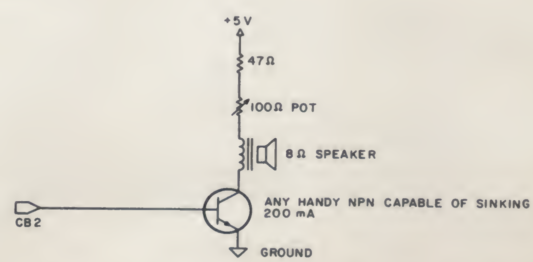

Fig. 4b. This circuit lets you add sound effects, etc., for you PET without any additional equipment. Take the +5 volts from the second tape port. (That's the top or bottom pin, second in from the side of the PET. Check your first tape recorder to find whether it is on top or bottom—Commodore makes both kinds!) Find a 2 or 3 inch speaker and any handy NPN transistor capable of 200 mA current. The 47 Ohm resistor should be 1/2 Watt or larger and should not be omitted. My unit was put on a 3 × 5 inch perfboard with connectors glued to one edge, which makes it easy to hook to my PET.

Data Directions Register	
POKE 59459, 255	Set user port to 8 bits output.
POKE 59459, 0	Set user port to 8 bits input.
Simple Input and Output (no handshakes)	
(value) = PEEK(59471)	Input (value) from user port.
POKE 59471, (value)	Output (value) to user port.
Input and Output with Handshaking	
POKE 59468, PEEK(59468) AND 254	CA1 will trigger on falling edge.
POKE 59468, PEEK(59468) OR 1	CA1 will trigger on rising edge.
POKE 59467, PEEK(59467) OR 1	Data is latched when CA1 triggers.
POKE 59467, PEEK(59467) AND 254	Data is not latched.
IF PEEK(59469) AND 2 THEN —	Three ways of detecting the CA1 Flag Bit.
WAIT 59469, 2	Be careful with using WAIT.
nnn IF(PEEK(59469) AND 2) = 0 THEN nnn	
(value) = PEEK(59457)	Reads from user port, resets CA1 flag bit.
POKE 59457, (value)	Writes to user port, resets CA1 flag bit.
POKE 59468, PEEK(59468) OR 224	Set CB2 line high.
POKE 59468, (PEEK(59468) AND 31) OR 192	Set CB2 line low.
Shift Registery	
POKE 59467, PEEK(59467) AND 227 OR 16	Sets shift register to free running mode.
POKE 59467, PEEK(59467) AND 227	Disables shift register modes.
POKE 59466, (value)	Puts (value) into shift register.
POKE 59464, (value)	Sets timer 2 to (value)
Miscellany	
(value) = PEEK(515)	Reads matrix value of key pressed. 255 = no keys pressed.
(value) = PEEK(516)	Reads shift keys. 1 if pressed, 0 otherwise.

Table 7. Summary of BASIC statements used to control the PET user port.

```
40 POKE A,X:POKEA,Y: GOTO 40
```

Line 10 disables the Shift Register mode, and line 40 turns CB2 on and off. The reason that variables are used in line 40 for the addresses is that BASIC runs much faster when variables are substituted for constants.

RUN the program, and a buzz will emerge from your speaker.

Try changing line 40 to:

```
40 POKE59468,X:POKE59468,Y:GOTO 40
```

and you will notice that the pitch of the buzz is much lower. (Note: You will also hear a variation in the pitch of the buzz. This is caused by the PET's interrupt routines "beating" with the execution of the BASIC program.)

A last variation before going on to the shift register is to change the above program as follows:

```
40 Z=515
50 POKE A,X:FOR J=1 TO PEEK(Z):
   NEXT: POKE A,Y: GOTO 50
```

Pressing different keys will vary the rate of clicking. (Note: Location 515 indicates which key is depressed on the PET keyboard. This is not in PET ASCII but represents the matrix position of the key.)

Shift Register Mode

When the ACR bits 4, 3 and 2 are "100" the shift register is in "free running mode." Two addresses are now of interest:

SR	Shift Register	59466
T2L-W	Timer-2	59464

At a rate determined by the contents of Timer-2, the contents of the shift register are placed on the CB2 line. When eight bits have been shifted out, the shift register is again shifted out. This creates a continuous stream of bits that repeats every eight Timer-2 cycles.

Timer-2 accepts a number from 0 to 225 and counts it down to zero at the PET clock rate. When it reaches zero, the shift register is shifted and the least significant bit (bit 0) is placed on the CB2 line.

By placing an appropriate number into Timer-2 for the pitch and a 15 into the shift register, square waves at audio frequency will emerge from CB2. Here is the world's clumsiest musical instrument (see Example 12). Try it and you will know why. Line 50 inputs a waveform to be put into the shift register when a key is pressed. Line 60 guarantees that the waveform will result in a sound (a 0 or a 255 will come out as a dc voltage).

Line 90 detects the state of the PET keyboard matrix. When no key is depressed, the value in this address is 255. Line 100 puts a zero into the shift register, turning the sound "off." Then the keyboard is checked again.

If a key is depressed, the "pitch," or the matrix value of the key, is put into the timer and the timbre is put into the shift register. Now a sound is heard (for most of the keys; some will

```
10 REM CLUMSY MUSIC MACHINE
20 REM SET S.R. MODE IN ACR
30 POKE 59467, PEEK(59467) AND 227 OR 16
40 PRINT"TIMBRE :";
50 INPUT TC
60 IF TC<1 OR TC>254 THEN 40
70 REM CHECK FOR KEYPRESSES
80 PRINT"PRESS KEYS FOR TONES"
90 K=PEEK(515)
100 IF K=255 THEN POKE 59466,0: GOTO 90
110 POKE 59464,K: POKE 59466,TC
120 K=PEEK(515): IF K=255 THEN 100
130 GOTO 120
```

Example 12. A clumsy music machine.

```
10 POKE 59467,PEEK(59467)AND 227 OR 16
20 POKE 59466,15
30 FOR J=0 TO 255; POKE 59464,J: NEXT
100 GET A$: IF A$="" THEN 30
110 POKE 59466,0
```

Example 13. Program for effect 1.

```
30 FOR J=10 TO 255 STEP 10: POKE 59464,J: NEXT
40 FOR J=255 TO 10 STEP -10: POKE 59464,J: NEXT
```

Example 14. Changes in Example 13 for effect 2.

```
30 FOR J=1 TO 100: POKE 59464, 240*RND(1)+10: NEXT
```

Example 15. Change in Example 13 for effect 3.

```
30 FOR J=1 TO 30: POKE 59464,100: POKE 59464,200: NEXT
40 FOR J=1 TO 30: POKE 59464,150: POKE 59464,250: NEXT
```

Example 16. Changes in Example 13 for effect 4.

make inaudibly high notes). Line 120 waits until the key is released before starting over at line 100.

Some time spent with a calculator or scope will yield about two octaves of pitches that are reasonably close to the musical scale(s). Feel free to write your own musical programs.

Since the CB2 line, once in Shift Register mode, will run independently of the PET's other activities, other computations may be done while a tone is sounded. Another aspect is the making of sound effects for games. See Examples 13-17 and try them out to find out what they do.

Lines 100 and 110 in Example 13 provide a way of turning the sound off. If you don't do this, the PET will squeak at you after you press the STOP key—and only a direct version of line 110 will turn the squeak off! Examples 14-16 show changes to Example 13.

```
10  REM BETTER WOLF
20  REM GREGORY YOB
30  REM CB2 ON USER PORT & AMP
100 POKE 59467,16 :POKE 59466,15
110 FOR L = 180 TO 50 STEP -3:POKE 59464,L:NEXT
111 FOR J = 1 TO 6:NEXT
112 POKE 59466,0
115 FOR J = 1 TO 150: NEXT
117 POKE 59466,15
120 FOR L = 150 TO 80 STEP -2: POKE 59464,L:NEXT
130 FOR L = 90 TO 190: POKE 59464,L
132 FOR J = 1 TO L/70: NEXT
134 NEXT
135 POKE 59467,0
140 PRINT"PRESS KEY TO DO IT AGAIN"
150 GET A$: IF A$ = "" THEN 150
160 GOTO 100
```

Example 17.

Summing Up

The PET user port is a versatile way with which to communicate between the PET and the rest of the world. This article has shown you the "nuts and bolts" required to interface many devices, including joysticks, keyboards and music makers, that add to the capabilities or your PET.

For your convenience, Table 7 summarizes the various BASIC statements used to control the user port. Now let me see . . . robots, turtles, printers, my lawn sprinklers. . . . ■

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Reader Service—see page 179

Reader Service—see page 179

Chess Pawn

Pawn strategy in chess is often overlooked. Look over this article and improve yours.

Edward E. Ewald, Jr.
2708 Sterling Dr.
Zephyrhills FL 33599

Chess Pawn, based on the standard moves of the pawn during the game of chess, is a fun game for two players. It was written in Benton Harbor extended BASIC. There are only a few changes from other versions of BASIC; with minimal work the program can be adapted to most other computers. The most notable change is Heath's use of LINE INPUT for string functions and INPUT for variables only (not including strings, unless the input is enclosed in quotation marks). On lines 20010, 21130 and 21140, Heath's string concatenation has been used.

The program can easily be expanded to a complete chess game with a little imagination; sufficient space has been left between the lines to allow for additions. For those adept in the game of chess it provides a good experience in pawn strategy, which is frequently overlooked by most players. The game is not as simple as it looks; one player will eventually get in a position where he cannot move. At that point the player who has captured the most pieces wins.

At first I attempted to use standard chess notation for moves, but I found that the game became extremely complicated and slowed down by the difficulty in thinking upside down for the black pieces. If one player could have been situated upside down above the CRT display, it would have worked just fine.

I took a modified approach, with all pieces referenced from the "whites" position (references are printed on the top and bottom of the display, and numbers are printed on the right side). The program allows for all standard chess moves for the pawn, including moving two spaces on the first move and capturing "en passant."

The board is printed in the beginning of the game and before each player's turn. It appears as shown in Fig. 1. The top line is the designation of the column that must be used during the game. From left to right, it reads: rook #1 (R1), knight #1 (N1), bishop #1 (B1), king (K), queen (Q), bishop #2 (B2), knight #2 (N2) and rook #2 (R2). Following the column headings are the name of player #2 and the pawns that he has captured.

The next line includes the top eight squares of the board, followed by a "1," indicating that it is line 1. The line number along with the column heading is used to indicate a move. Line 2 is the starting position for the black pawns. The asterisk before the pawn number indicates that it is black. Line 7 is the starting position for the white pawns. White pawns have no asterisk. At the bottom of the board are the column headings followed by the name of player #1 and the black pawns that

```
R1  N1  B1  K   Q   B2  N2  R2          name   pieces captured
--  --  --  --  --  --  --  --  1
*P1 *P2 *P3 *P4 *P5 *P6 *P7 *P8 2
--  --  --  --  --  --  --  --  3
--  --  --  --  --  --  --  --  4
--  --  --  --  --  --  --  --  5
--  --  --  --  --  --  --  --  6
 P1  P2  P3  P4  P5  P6  P7  P8 7
--  --  --  --  --  --  --  --  8
R1  N1  B1  K   Q   B2  N2  R2          name   pieces captured
```

Fig. 1.

```
                    CHESS-PAWN
FIRST PLAYER? TED
SECOND PLAYER? STAN
BOARD IS AS FOLLOWS:
R1  N1  B1  K   Q   B2  N2  R2       STAN
--  --  --  --  --  --  --  --   1
*P1 *P2 *P3 *P4 *P5 *P6 *P7 *P8  2
--  --  --  --  --  --  --  --   3
--  --  --  --  --  --  --  --   4
--  --  --  --  --  --  --  --   5
--  --  --  --  --  --  --  --   6
 P1  P2  P3  P4  P5  P6  P7  P8  7
--  --  --  --  --  --  --  --   8
R1  N1  B1  K   Q   B2  N2  R2       TED
IT IS TED'S TURN
MOVE WHICH PIECE? P2
TO? (EXAMPLE N1) ?N1
POSITION? (EXAMPLE 5) ?5
R1  N1  B1  K   Q   B2  N2  R2       STAN
--  --  --  --  --  --  --  --   1
*P1 *P2 *P3 *P4 *P5 *P6 *P7 *P8  2
--  --  --  --  --  --  --  --   3
--  --  --  --  --  --  --  --   4
--   P2 --  --  --  --  --  --   5
--  --  --  --  --  --  --  --   6
 P1 --   P3  P4  P5  P6  P7  P8  7
--  --  --  --  --  --  --  --   8
R1  N1  B1  K   Q   B2  N2  R2       TED
IT IS STAN'S TURN
MOVE WHICH PIECE? P2
TO? (EXAMPLE N1) ?N1
POSITION? (EXAMPLE 5) ?4
R1  N1  B1  K   Q   B2  N2  R2       STAN
--  --  --  --  --  --  --  --   1
*P1 --  *P3 *P4 *P5 *P6 *P7 *P8  2
--  --  --  --  --  --  --  --   3
--  *P2 --  --  --  --  --  --   4
--   P2 --  --  --  --  --  --   5
--  --  --  --  --  --  --  --   6
 P1 --   P3  P4  P5  P6  P7  P8  7
--  --  --  --  --  --  --  --   8
R1  N1  B1  K   Q   B2  N2  R2       TED
IT IS TED'S TURN
MOVE WHICH PIECE? P7
TO? (EXAMPLE N1) ?N2
POSITION? (EXAMPLE 5) ?5
        Eventually that game evolved into the following:
R1  N1  B1  K   Q   B2  N2  R2      STAN  P5  P7
--  --  --  --  --  --  --  --   1
*P1 --  *P3 --  --  --  *P7 --   2
--  --  --  --  --  *P6 *P8 --   3
--  *P2 --  --  --  --  --  --   4
--   P2 --  *P5 --   P6 --  --   5
--  --  --  --  --  --  --  --   6
 P1 --   P3  P4 --  --  --   P8  7
--  --  --  --  --  --  --  --   8
R1  N1  B1  K   Q   B2  N2  R2      TED  *P4
IT IS TED'S TURN
MOVE WHICH PIECE? P1
TO? (EXAMPLE N1) ?R1
POSITION? (EXAMPLE 5) ?6
        At the end of the game the board looked like this:
R1  N1  B1  K   Q   B2  N2  R2      STAN  P5  P7  P6  P3  P4  P8  P2  P1
--  --  --  --  --  --  --  --   1
--  --  --  --  --  --  --  --   2
--  --  --  --  --  --  *P7 --   3
--  *P1 --  --  --  --  --  --   4
--  --  --  --  --  --  --  *P6  5
--  --  *P2 --  --  --  --  --   6
--  --  --  --  --  --  --  --   7
--  --  --  --  --  --  --  --   8
R1  N1  B1  K   Q   B2  N2  R2      TED  *P4  *P8  *P5  *P3
```

Fig. 2. Sample run.

have been captured.

The object of the game is for player #1 to capture as many of the black pawns as possible. Rarely is it possible to get all your pawns across the board. The game ends when one player cannot move. The player with the most pawns captured wins.

A recent game I played went along as shown in Fig. 2. The defeat was my fourth loss in a row.

I'll put the H8 in the programming mode and start programming another game. I hope everyone has better luck than I.■

Program listing.

```
10 PRINT "              CHESS-PAWN"
20 DIM C$(8,8),E1(9),E2(9)
30 FOR I=1TO 8:FOR J=1TO 8
40 C$(I,J)="--  "
50 NEXT J:NEXT I
60 C$(2,1)="*P1 ":C$(2,2)="*P2 ":C$(2,3)="*P3 ":C$(2,4)="*P4 "
70 C$(2,5)="*P5 ":C$(2,6)="*P6 ":C$(2,7)="*P7 ":C$(2,8)="*P8 "
80 C$(7,1)=" P1 ":C$(7,2)=" P2 ":C$(7,3)=" P3 ":C$(7,4)=" P4 "
90 C$(7,5)=" P5 ":C$(7,6)=" P6 ":C$(7,7)=" P7 ":C$(7,8)=" P8 "
100 LINE INPUT "FIRST PLAYER? ";A$
110 LINE INPUT "SECOND PLAYER? ";B$
120 PRINT :PRINT "BOARD IS AS FOLLOWS:"
1000 GOSUB 10000
1010 PRINT "IT IS "A$"'S TURN"
1020 LINE INPUT "MOVE WHICH PIECE? ";P$
1030 P=1:R=0
1040 LINE INPUT "TO? (EXAMPLE: N1) ?";M$
1050 INPUT "POSITION? (EXAMPLE: 5) ?";M
1060 IF M>8THEN 1020
1070 GOSUB 20000:IF R=1THEN 1000
2000 GOSUB 10000
```

```
2010 PRINT "IT IS "B$"'S TURN"
2020 LINE INPUT "MOVE WHICH PIECE? ";P$
2030 P=2:R=0
2040 LINE INPUT "TO? (EXAMPLE: N1) ?";M$
2050 INPUT "POSITION? (EXAMPLE: 3) ?";M
2060 IF M>8THEN 2020
2070 GOSUB 20000:IF R=1THEN 2000
2080 GOTO 1000
10000 PRINT "R1  N1  B1  K   Q   B2  N2  R2      "B$,Z$
10010 FOR I=1TO 8:FOR J=1TO 8
10020 PRINT C$(I,J);
10030 NEXT J:PRINT I:NEXT I
10040 PRINT "R1  N1  B1  K   Q   B2  N2  R2      "A$,Y$
10050 RETURN
20000 REM *** FIND POSITION OF PIECE ***
20010 E$=" "+P$+" ":F$="*"+P$+" ":FOR I=1TO 8:FOR J=1TO 8
20020 IF P=1AND C$(I,J)=E$THEN A=I:B=J:GOTO 20060
20030 IF P=2AND C$(I,J)=F$THEN A=I:B=J:GOTO 20060
20040 NEXT J:NEXT I
20050 PRINT "CHESS PIECE NOT FOUND - REPEAT MOVE":R=1:RETURN
20060 REM *** EVALUATION ***
20070 REM *** FIND POSITION OF MOVE ***
20080 C=M
20090 IF M$="R1"THEN D=1:GOTO 20180
20100 IF M$="N1"THEN D=2:GOTO 20180
20110 IF M$="B1"THEN D=3:GOTO 20180
20120 IF M$="K"THEN D=4:GOTO 20180
20130 IF M$="Q"THEN D=5:GOTO 20180
20140 IF M$="B2"THEN D=6:GOTO 20180
20150 IF M$="N2"THEN D=7:GOTO 20180
20160 IF M$="R2"THEN D=8:GOTO 20180
20170 PRINT "INVALID MOVE":R=1:RETURN
20180 REM  *** FIND PIECE BEING MOVED ***
20190 IF LEFT$(P$,1)="P"THEN 21000
20200 PRINT "INCORRECT CHESS PIECE INDICATED!":R=1:RETURN
21000 REM  *** EVALUATE PAWNS MOVE ***
21010 IF P=1AND A=7AND C=5AND D=B AND LEFT$(C$(C,D),1)="-"THEN 21300
21020 IF P=2AND A=2AND C=4AND D=B AND LEFT$(C$(C,D),1)="-"THEN 21320
21030 IF C=A AND D=B+1THEN 21400
21040 IF C=A AND D=B-1THEN 21400
21050 IF P=1AND C=A-1AND D=B-1THEN 21130
21060 IF P=1AND C=A-1AND D=B THEN 21200
21070 IF P=1AND C=A-1AND D=B+1THEN 21130
21080 IF P=1THEN PRINT "ILLEGAL MOVE":R=1:RETURN
21090 IF P=2AND C=A+1AND D=B-1THEN 21130
21100 IF P=2AND C=A+1AND D=B THEN 21200
21110 IF P=2AND C=A+1AND D=B+1THEN 21130
21120 IF P=2THEN PRINT "ILLEGAL MOVE":R=1:RETURN
21130 IF P=1AND LEFT$(C$(C,D),1)="*"THEN Y$=Y$+C$(C,D):GOTO 21160
21140 IF P=2AND LEFT$(C$(C,D),1)=" "THEN Z$=Z$+C$(C,D):GOTO 21170
21150 PRINT "INVALID MOVE":R=1:RETURN
21160 C$(C,D)=E$:C$(A,B)="--  ":RETURN
21170 C$(C,D)=F$:C$(A,B)="--  ":RETURN
21200 IF P=1AND LEFT$(C$(C,D),1)="-"THEN 21160
21210 IF P=2AND LEFT$(C$(C,D),1)="-"THEN 21170
21220 PRINT "POSITION TAKEN BY OPPONENT":R=1:RETURN
21300 REM  *** SET UP EN PASSENT FILE ***
21310 IF LEFT$(C$(A-1,B),1)="-"THEN E1(B)=1:GOTO 21160
21320 IF P=2AND LEFT$(C$(A+1,B),1)="-"THEN E2(B)=1:GOTO 21170
21330 PRINT "POSITION TAKEN BY OPPONENT":R=1:RETURN
21400 IF P=1AND E2(D)=1THEN 21100
21410 IF P=2AND E1(D)=1THEN 21110
21420 PRINT "EN-PASSENT INVALID":R=1:RETURN
```


✓ Reader Service—see page 179

Exterior Ballistics with the Home Computer

Don't ban guns or computers, says Dave. Use them in conjunction with each other.

David S. Dixon
1810 Flora Circle
Las Cruces NM 88001

If you have friends or relations who are hunters or target shooters, you will probably want to add this exterior ballistics program to your program library. The program will calculate the remaining velocity, sight corrections and point of impact versus line of sight. Since I first wrote the program, I have had frequent requests for a demonstration run or a phone call from a friend with a new pet load requesting a run.

The program has run on my SWTP 6800 using both version 1.0 and 2.0 of the SWTP 8K BASIC and 12K bytes of RAM. I think that a slightly abbreviated program could run in 8K bytes and not sacrifice more than a little elegance in I/O operations if the version 1.0 BASIC were used. To use the program with another BASIC, the BASIC will have to provide addition, subtraction, multiplication and exponentiation to perform the calculations.

Don't let the brevity and simplicity of the program deceive you. It produces surprisingly accurate results. The program is based on the McGehee Ballistic functions[1], which are maxicomputer solutions of the more complex Mayevski Ballistic functions[2]. So your microcomputer is working on a problem that has been predigested for it by the larger system.

In 1966, I had the opportunity to observe a large IBM system running an exterior ballistics program based on the Mayevski functions. Even though it was running it as a compiled program as opposed to an interpreter, the execution speed was at least 50 times slower than the program in this article; this should give you some idea of how much the solution has been simplified by the McGehee functions.

The program listing is included. I have left REM statements out and will comment about the program in the following text instead.

Program lines 90-400 and 1000-1100 are input and machine setup (number of digits, etc.). Only line 200, where the coefficient K is calculated, pertains to the actual ballistics calculation.

Program lines 500-800 and 1150-1610 calculate the trajectory and sight corrections.

Lines 2000-2500 are a subroutine that calculates the total drop at range X(I).

Lines 2600-2900 calculate the remaining velocity at range X(I).

Lines 1700-1720 are output.

A special note to anyone rewriting portions of the program: The input and output dimensions for the McGehee functions used in this program are velocity in thousand feet/sec. (3000 fps = 3.0), range in hundred yards (100 yds. = 1.0) and drop in inches.

You will have to remember the conversions to and from these dimensions in any changes to the program. The execution time of the program can be significantly improved by moving lines 2000, 2100, 2200, 2600 and 2700 to locations between 400 and 700. The above lines are within a loop where they are unnecessarily evaluated with each pass through the loop. These lines were placed where they are in the listing to simplify blocking out the functions of each portion of the program. You can move them and rewrite the subroutine entry locations, or leave them as they appear. The program will work either way.

The inputs to the program are the ballistic coefficient of the bullet, the muzzle velocity, the range at which the rifle is zeroed and the ranges at which the trajectories are to be calculated.

The ballistics coefficient is a measure of the bullet's performance compared to a standard projectile. The common manufacturers of bullets, Sierra, Speer, Hornady, Nosler, etc., all provide for the bullets they manufacture ballistic coefficients that are appropriate for use with this program. These coefficients can be found in the manufacturer's reloading manual.

```
0090 LINE= 80
0100 DIGITS= 3
0101 INPUT "BALLISTIC C",C
0110 INPUT "MUZZLE VEL.",VO
0120  VO = VO/1000
0200  K=1/(C*VO↑.75)
0300 INPUT "NO. OF RANGES",L
0400 DIM X(L)
0500 INPUT "ZERO RANGE",X(1)
0510  X(1) = X(1)/100
0600  I=1
0700 GOSUB 2000
0800  D=Y
0900 FOR I=1 TO L
1000 PRINT "RANGE",I
1050 INPUT X(I)
1060  X(I) = X(I)/100
1100 NEXT I
1150 FOR I=1 TO L
1200 GOSUB 2000
1300  U=(Y-D)*X(I)
1400 GOSUB 2600
1500  V=V1*1000
1600  R=X(I)*100
1610  J = -U/(X(I)*1.05)
1700 PRINT "RANGE",R,"DROP",U
1710 PRINT "VELOCITY",V,"CORR. IN MOA.",J
1720 PRINT
1800 NEXT I
1900 STOP
2000  B1=17.6/VO↑2
2100  B2=.05*K*(1-.6/VO)*B1
2200  B3=.1815*K*(1-1.2/VO)*B2
2300  Y1=((B3*X(I)+B2)*X(I)+B1)*X(I)↑2
2400  Y=-(Y1+1.5)/X(I)
2500 RETURN
2600  A1=.0823*K*(1-.45/VO)
2700  A2=.198*K*(1-1.65/VO)*A1
2800  V1=VO/((A2*X(I)+A1)*X(I)+1.003)
2900 RETURN
```

Program listing.

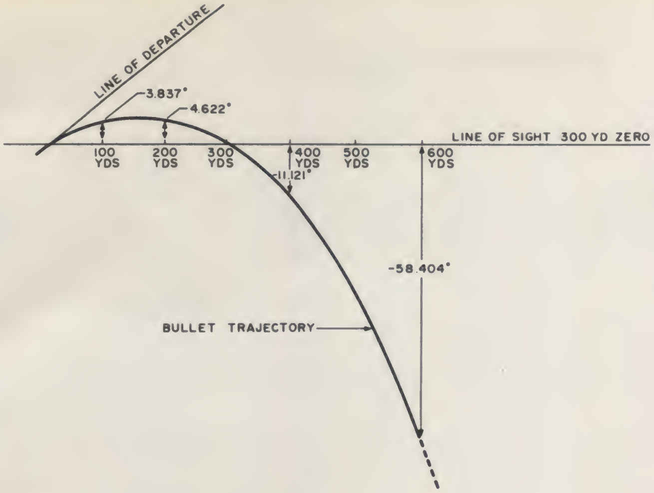

Fig. 1.

```
RUN
BALLISTIC C? .409
MUZZLE VEL.? 3000
NO. OF RANGES? 5
ZERO RANGE? 300
RANGE          1.000
? 100
RANGE          2.000
? 200
RANGE          3.000
? 300
RANGE          4.000
? 400
RANGE          5.000
? 600
RANGE          100.000        DROP             3.837
VELOCITY       2764.456       CORR. IN MOA.    -3.654

RANGE          200.000        DROP             4.622
VELOCITY       2538.608       CORR. IN MOA.    -2.201

RANGE          300.000        DROP             0.000
VELOCITY       2320.837       CORR. IN MOA.    0.000

RANGE          400.000        DROP             -11.121
VELOCITY       2115.855       CORR. IN MOA.    2.648

RANGE          600.000        DROP             -58.404
VELOCITY       1753.003       CORR. IN MOA.    9.270

STOP 1900
READY
#
```

Sample run.

The various reloading manuals are also sources of good estimates for the muzzle velocities of the various reloads.

The program outputs are the range, the drop below line of the rifle's sights, the remaining velocity and the corrections in minutes of angle, which is the angular value to correct from the initial zeroing range to impact at point of aim for the range calculated.

The sample run shows a 30 cal., 150 gr. Sierra bullet fired at a muzzle velocity of 3000 ft/sec, rifle to be zeroed at 300 yds., and trajectory calculated for 100, 200, 300, 400 and 600 yards (Fig. 1).

The only restriction on the use of the program is that its accuracy deteriorates rapidly for remaining velocities below 1300 ft/sec.

I have not covered exterior ballistics in detail. That is beyond the scope and intent of this article. I would like to point out some areas not touched upon. First there are a number of adjustments to the ballistic coefficient to correct for changes in atmospheric conditions. Reference 3 has a very good section on this.

Also, I have not mentioned how you could evaluate a bullet for which you do not have a published value for the ballistic coefficient. Reference 2 covers this process in detail.

Exterior ballistics is a fertile territory for the hobby computerite. I have started some work on a program for optimum projectile selection for long-range competition shooting, and there are topics of stability or wind drift that can be handled by a small system. Solutions to problems like these can form the foundation for articles in a sporting magazine as well as a personal computing publication, and also can afford the author a great deal of pleasure and recreation in their generation. ■

References

1. Ralph M. McGehee, PhD, "Practical Ballistics," *The Rifle Magazine*, Number 9, May-June 1970, pp. 40-45.
2. Julian S. Hatcher, *Hatcher's Notebook*, 1962, pp. 549-632.
3. Robert Hayden, *Sierra Bullets Reloading Manual*, 1974, pp. 231-246.

Heath H9 Page Erase

Since the H9 doesn't have inherent screen erase under program control, add it yourself.

William C. Richter
1001-140 Evelyn Terrace East
Sunnyvale CA 94086

The Heath H9 video terminal has many features, but it does not include the ability to erase the screen under program control. Since I wanted this feature, I set out to see if Heath's omission could be easily corrected. The result is a low-cost (under $5) peripheral that requires only six connections to the terminal and no major modification of any of the boards. If you have built the H9, this little add-on should not present any construction or wiring problems.

In the past, there have been magazine articles describing methods of decoding the control characters and using them for external control. In the H9, the decoder is already present on the I/O board and detects back space, bell, line feed, carriage return and space.

I added an additional NOR gate to the decoder to detect CNTRL-E (for ERASE) and to use the output of the gate, with a little more circuitry, to "push" the ERASE PAGE key on the keyboard. I chose CNTRL-E because it was the first control code not used or reserved by Heath; any other unused control code could be chosen by proper connections to the pins of IC614 and IC623. IC623 decodes the units of the octal character code, and IC614 decodes the tens, or eights, if you prefer.

The Circuit

The add-on circuit (see Fig. 1) consists of some logic gates driving a one-shot multivibrator which turns on a transistor to electrically push the ERASE PAGE key. U1A detects the presence of octal 05 at the I/O decoders to produce a logic 1, which is then inverted by U1B. U1D inverts the logic 1 from the PLOT key, and U1C combines this with the logic 0 from U1B to trigger the one-shot.

When the PLOT key is depressed, U1C is disabled, and the one-shot is not triggered. This enables the use of CNTRL-E in the plot mode of operation, without screen erasure. C1 filters out glitches that seem to occur while data is settling in the decoders. I was getting screen erasure on random characters before C1 was added.

When U2 is triggered, its output is a pulse about 5 ms wide, controlled by timing components C2 and R1. The H9 manual states that a screen erase takes about 1 ms, so anything over that time will do the job. The output of U2 controls Q1, which is in parallel with the ERASE PAGE push button.

Construction

I constructed the circuit on a 1 1/8 by 3 inch piece of perforated board using "stick-on" copper-printed circuit pads for the ICs and point-to-point wiring. With so few parts, construction is relatively easy.

The board is mounted under the right-hand side of the keyboard by replacing the 4-40 nut on the keyboard support bracket with a 4-40 1/2 inch threaded spacer and then fastening the board to the spacer. The four jumpers to the keyboard are soldered to their proper places in the circuit; although I have indicated the connector pin numbers on the schematic, the wires can be soldered to traces much closer to the board. Refer to your circuit board X-ray views.

To preserve the "plugability" of the boards, I used spare plug and socket connections for the two jumpers to the I/O board. On the I/O board, jumpers from IC614-1 and IC623-6 were connected to unused pins 24 and 25 of P602. Two 18 inch lengths of wire are needed with a small spring connector (Heath part #432-866) on one end of each and a large spring connector (Heath part #432-753) on the remaining ends. There should be connectors left over from the terminal construction project.

Insert the small clips into positions 24 and 25 of S602, route the wires to the keyboard and insert the large clips into positions 10 and 11 of S402. Finally, add jumpers from P402-10 and P402-11 to pins 8 and 9 of U1A. It makes no difference which wire connects to which pin; the end result is the same.

Testing

Now you are ready to test your modification. With the terminal connected to your computer, enter a program to write some characters on the screen, erase the screen and write some more. With Extended Benton Harbor BASIC, a PRINT CHR$(5) statement will erase the screen and home the cursor. For other versions of BASIC, or even other languages, use whatever is necessary to output a CNTRL-E to the terminal.

If you find you are missing a couple of characters after a screen erase, add a short delay loop to your program after the CNTRL-E is sent. In conclusion, if you like to erase your screen under program control, this is an easy and inexpensive way to do it. ■

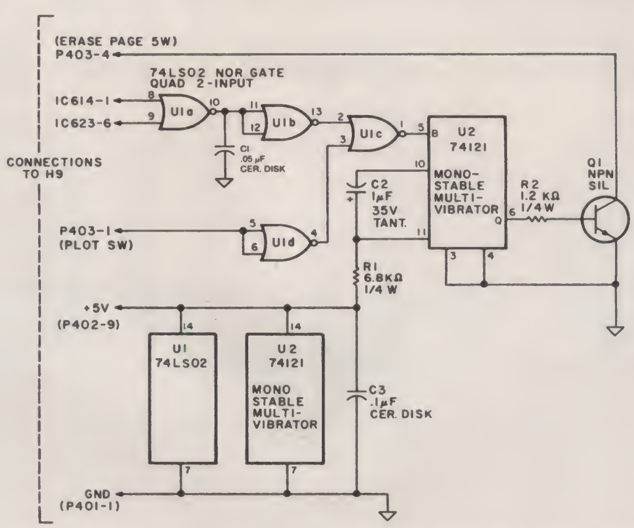

Fig. 1. Modification of Heath H9 video terminal to erase the screen under program control.

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SKIP II: A Very Inexpensive Microcomputer

"SKIP II, my low-cost introduction to microcomputers."—Author.

The SKIP II kit as it arrived in the mail. The black object in the center is the 40-pin socket for the SC/MP-II microprocessor chip, shown wrapped in foil just below the socket.

When I first began to look at home computer systems with the idea of actually buying one, it wasn't long before I had to decide exactly what I wanted. Did I want a system that you take home, unpack, plug it in and begin programming? Or would it be more fun—and would I learn more—if I bought a basic, single-board system that could be expanded at a later date? A trip to my local computer store made the decision for me—the ready-to-run systems were simply out of my price range. Therefore, it would have to be a single-board computer.

Once I made that decision, I was faced with another: which single-board system should I buy? There were, and still are, many of these on the market, and it's no easy task to decide which one best suits your purpose. After reading literature on the more popular and well-known systems (such as the

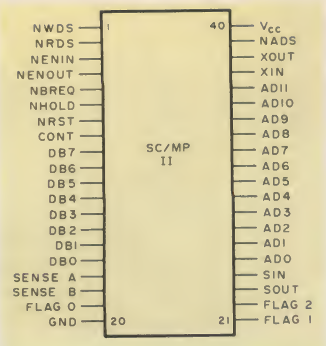


Fig. 1. Pin-out information.

KIM, the COSMAC Elf and the E&L MMD-1), I found what I was looking for in a kit manufactured and sold by NBL in Richardson, Texas.

Basically, I was looking for three things. First, I wanted to learn as much as I could about the hardware end of microcomputers, both the design phase and construction techniques. Second, I wanted a kit that could be expanded to a maximum configuration system at a *reasonable* cost and on a "money available" basis. Finally, I didn't want to have to mortgage my house and car to buy the basic computer.

The SKIP II kit from NBL filled the bill perfectly, and I would like to tell you about both the kit and my experiences in constructing it. Please bear in mind that I had never worked with printed circuits before this and knew very little about hardware or digital design. My knowledge was confined to software design and systems programming on large, multi-user systems.

The SC/MP-II Chip and SKIP II

The heart of the SKIP II microcomputer is the SC/MP-II microprocessor chip manufactured by National Semiconductor. This little known but quite powerful processor chip is gaining in popularity among hobbyists. Constructed as a standard n-channel, 8-bit microprocessor in a 40-pin DIP, the SC/MP-II was originally intended for use in general-purpose applications such as test systems, process controllers, word-processing systems and the like. However, because of its low cost, strong instruction set, versatility and ease of interfacing with almost all of the peripherals available today, the SC/MP-II is ideally suited for the hobbyist.

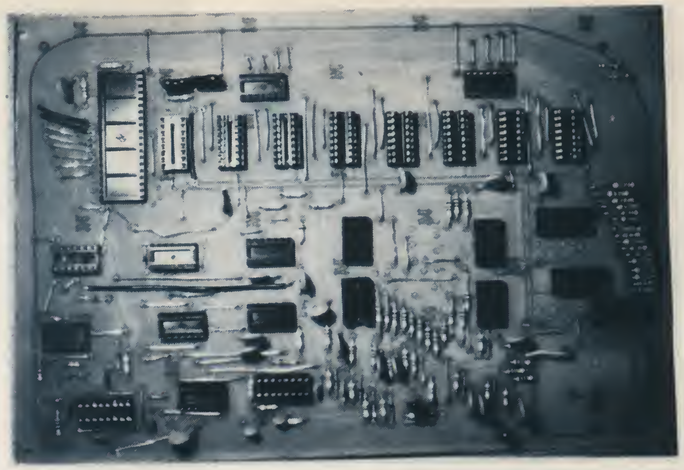
The Simple Cost-effective Micro Processor, version II is capable of addressing up to 65K of memory, contains both serial and parallel data transfer instructions as well as its own timing circuitry and is designed for low power consumption. It requires a single +5 volt power supply (unlike the original SC/MP, which required both a +5 and a −7 volt supply). The pin-out information is shown in Fig. 1, while a typical application utilizing the SC/MP-II is shown in Fig. 2. Note that the SC/MP and the SC/MP-II are software compatible but *not* pin-out compatible—several signals changed from active low on the SC/MP to active high on the SC/MP-II or vice versa.

NBL interfaced a keyboard and an array of LEDs to the various chip inputs, providing a way to input and output data. A complete 1K of RAM was added along with the required control circuitry. The entire computer consists of two parts: the printed circuit board containing 27 integrated circuits and a screen-printed front panel containing the keyboard, control buttons and LED readouts.

The keyboard is interfaced directly to the CPU without use of a ROM. Several control buttons are provided.

RESET aborts any program in progress and sets the program counter to zero so that the first instruction will be read from memory location 001. It also puts the computer under the control of the buttons on the front panel, where it remains until the EXECUTE button is depressed. While the computer is in this manual mode, data can be read into or out of sequential memory locations by contacting the READ/WRITE button. To debug programs, they may be executed one step at a time by use of the ADVANCE EXECUTE button. In fact, you can execute a program you are loading one step at a time by use of this ADVANCE EXECUTE button.

A bootstrap program is required to install breakpoint halts or to address a specific memory location anywhere within the memory. This very simple procedure is explained in detail in the programming guide accompanying the kit. More information on the SKIP II may be obtained by writing NBL, Box 1564, Richardson TX 75080.



Final stages of construction of the PC board. The SC/MP-II socket is in the upper left with the memory sockets to its right.

Constructing the SKIP II

Now that we know a little about the SKIP II and the SC/MP-II chip itself, let's turn our attention to building the kit. I'd like to discuss my experiences during kit construction, followed by a critical analysis of both the kit and my experiences, and end with some enhancement ideas I've been considering. Again, bear in mind that prior to the postman's delivering my SKIP II kit, my electronics experience was confined to building several simple Heath products.

Thanks to the excellent packing by NBL, even the postal service couldn't damage the kit components. It arrived in excellent condition (see "arrival" photo). Note that in my kit the only IC included was the SC/MP-II chip itself. I elected to save a few dollars by utilizing some chips already in my parts bin plus a few purchased through surplus sources. NBL offers all ICs as part of their package.

I was immediately impressed with the quality of the kit, especially the printed circuit board. Approximately 9×11 inches in size, all of the traces were cleanly etched with only a single copper "splatter," which

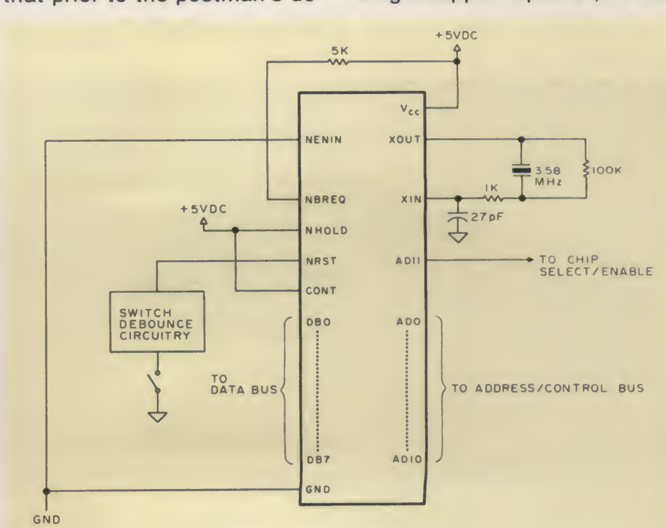


Fig. 2. A generalized SC/MP-II application.

I easily removed with an X-acto knife. There was also evidence of a quality-control type of inspection prior to shipment—one of the traces had been repaired by bridging a small gap with a piece of wire. I feel that this speaks highly of NBL and their concern for their finished product, since the first step in the construction process is to visually check the PC board for gaps, shorts, splatters and other defects. Even though NBL knows the customer is going to inspect the board himself, they still make that final check prior to shipment.

After carefully reading over all of the instructions several times, I began the actual construction by separating the various resistors, capacitors and diodes according to values. This, I reasoned, would make it easier to find the various parts during the soldering process. Besides, NBL furnishes a resistor value table that I wanted an excuse to use!

The next step was to cut the leads from most of the discrete components. It began to appear that this would take at *least* a week, until I realized that I could make a simple jig and not have to measure each lead individually. After measuring the various distances on a piece of paper taped to my bench, I finished the rest of the parts in less than 15 minutes.

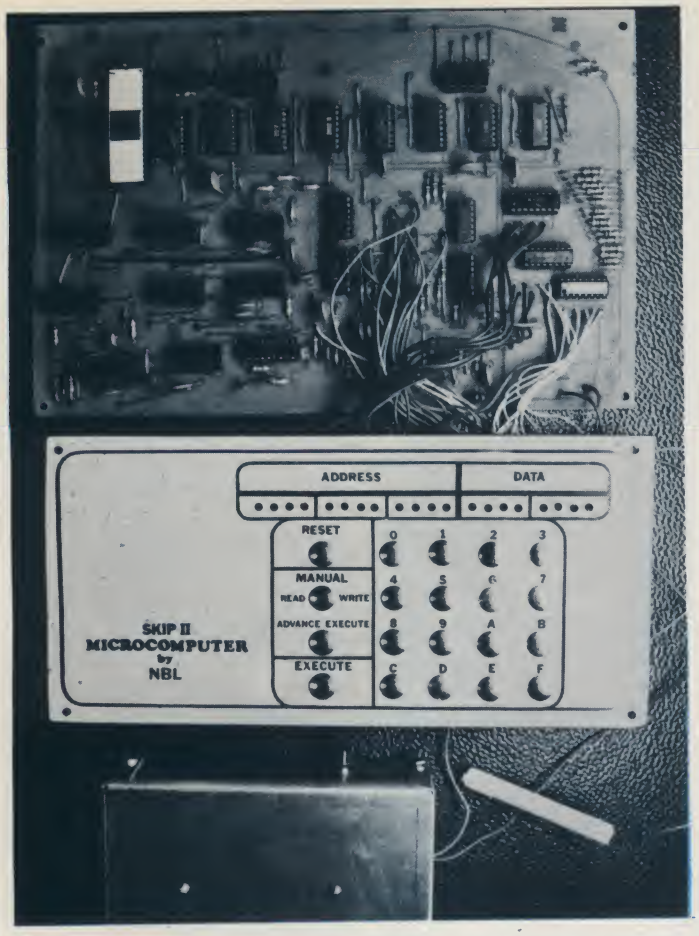
Next, following instructions, I used the cut leads (where possible) or insulated hookup wire to insert the jumper wires into the PC board. There were quite a few, but the illustrated instructions made it easy. I checked and double-checked the placement of the wires, then soldered them into place and checked the solder joints. Everything appeared to be OK, so I continued on to the next step: installing the resistors, diodes, capacitors and transistors.

Again, the clearly illustrated instructions made it easier than I thought it would be. The only problems I encountered resulted from my own errors—I installed one of the diodes backwards and had to replace it. Fortunately, I hadn't gone too far before discovering the error, so the board was relatively uncluttered. Things were really going smoothly, and the computer began taking shape before my eyes.

Next came the SC/MP-II socket. This was the only area in which I had problems with my soldering—those solder pads are *so* small! Diverging from the instructions just a bit, I also installed sockets for the rest of the ICs. These aren't called for by NBL—indeed, you could probably do without them and save a few dollars—but I wasn't too experienced in soldering and didn't want to take a chance on ruining the components. After soldering all the sockets into place—there are a *lot* of leads on that board—I inserted all the ICs *except* the SC/MP-II chip. I only bent one lead over—not too bad, considering all of the opportunities I had! The PC board was now complete. On to the front panel!

The unique keyboard arrangement is one that I personally like. It consists of 20 thumbtacks for keys and a probe with which the operator contacts the desired key when entering data or instructions. Granted, it is such a novel approach that it looks a little strange when you first see it, especially when you compare it to the *fancy front* panels on the higher-priced machines. However, it works well and is extremely easy to use. The cost savings realized by using the thumbtack-probe assembly instead of an expensive hex keyboard were used to improve the overall performance of the computer, making the SKIP II the only computer with a full 1K of RAM selling for less than $100.

The reverse side of the front panel contains solder pads for connection with the data, control and address *lines*, the LEDs (all 20 of them) used for display of the data and address bus contents, and the keyboard probe assembly. Following instructions, I soldered the LEDs and their associated current-limiting resistors into place, then connected the various bus wires from the PC board to the



The completed SKIP II kit with all ICs installed and the address, data and control buses in place. The box at the bottom of the photo is the 5 volt power supply.

front panel. The only problems I encountered here were caused by a basic lack of coordination on my part—I could have used at least three hands! Fortunately, my wife was willing to assist me, and we finally got everything soldered into place.

Once the front panel was complete, it was time to apply power to the circuit. Connecting a regulated 5 volt power supply to the board (I used a Radio Shack project board, but NBL furnished complete instructions for scratch-building a suitable power source), I made one last visual check of both the board and the front panel. Not finding any obvious errors, I applied power and, lo and behold, it worked! Not only did the lights come on, but there was neither smoke, nor flames nor strange noises!

The instructions say to let the system "burn in" for a few minutes. I left it powered up for about 15 minutes, then powered it down to insert the SC/MP-II chip. One more visual check, and I powered it up again with identical results—no surprises at all.

The construction manual also contains a preliminary system checkout guide that allows you to exercise each portion of the circuit and test the function of each key. While performing this preliminary check, I discovered that the READ/WRITE key didn't function properly. Trying to utilize this opportunity for learning to the fullest, I got into the final portion of the manual—troubleshooting.

I traced the circuit through from panel to board, comparing the readings from my VTVM to the chart of pin voltages supplied in the troubleshooting section of the manual. Everything seemed OK. I was just about to throw up my hands in despair when I realized that the signal

Reader Service—see page 179

at that last pin was high when it should have been low and that it had remained low for an extra cycle. Stepping back to the previous component, I discovered that I had inadvertently inserted the two transistors backwards!

After unsoldering the connections, I re-oriented the components and re-soldered them to the board. I then ran through the preliminary check again and discovered that everything worked exactly as advertised. My computer was finished!

Now came programming—my favorite activity, I might add—and here again NBL was prepared with a complete, easy-to-understand programming guide. I had previously joined a users' group sponsored by National Semiconductor for those owning systems based on the SC/MP (both I and II), IMP and PACE products, and had read everything available on programming the SC/MP. I had also purchased National's programming guide, which, with my experience in programming, would really have been sufficient for me to start programming my SKIP II. However, the NBL programming text had a basic advantage over the National text because it was written specifically for the system I had. National's book assumes that you have, as a minimum, a TTY with their Kitbug monitor routine stored in ROM.

The NBL programming guide takes each of the SC/MP-II's 46 instructions and three addressing modes and explains each one in detail. A simple program centered around each instruction is introduced with a full explanation of what the system is doing at each step. The programs progress in complexity from an easy "2 + 2 = 4" to the point where, as NBL states, "the only limitation is the imagination of the programmer." After covering the programming guide, I struck out on my own and to date have written several programs that, although they solve no earth-shattering problems, allow me to develop a feel for the way my new computer system operates.

Evaluation

Overall, I have to say that the SKIP II kit is great. The printed circuit board is quite well done, the components are of the highest quality and the documentation is superb. Although I *did* have a few problems during construction, the majority of them were as a result of my own errors or lack of knowledge. I received one of the first kits off of the assembly line and, as a result, found a few errors in the diagrams, instructions and commentary in the construction manual. However, a quick letter to NBL resulted in a clarification and corrected page in all cases. If asked whether I would purchase another kit from these folks, I would have to answer resoundingly, "yes!"

Speaking of other kits leads me into the last topic of this article. What enhancements to the basic system are planned? Obviously, with only 1K of RAM, a 20-key hex keyboard and a string of LED readouts, the system is limited to somewhat simpler tasks. In order to increase the usefulness of my system, I have planned, and am currently working on, the following:

1. A full ASCII keyboard—possibly a kit (such as the one from Radio Shack) or perhaps a scratch-built unit.
2. Conversion of the 20 separate LEDs to the popular 7-segment readouts.
3. Installation of PROM (at least 8K) to contain the monitor and service routines I currently have and those I will develop.
4. At least 8K of RAM. Of course, this will entail building a larger power supply, designing a suitable cabinet, etc.
5. An experiment to attempt to interface a scientific calculator chip to the system. I'm not entirely sure this is practical, but I can't find anything that says it's impossible!

In addition, the folks at NBL tell me that they are working on what I call "variations on a theme," i.e., they are designing a series of kits and games to utilize the various sense inputs and outputs currently unused in the SKIP II. They are also working on TV and cassette interfaces and considering the possibility of offering compatible memory boards, games and related products.

Conclusion

Well, there you have it. I hope you found my experiences with the SKIP II kit interesting and informative. I believe that I accomplished what I originally set out to do: I have a system that I built (and thus understand the operation of), that is expandable to as large a system as I wish and that taught me a tremendous amount about digital design and construction techniques utilizing printed circuit boards.

I hope that those of you who are in the position I was in before I built the SKIP II will seriously consider this fine kit as a low-cost introduction to the fascinating world of microcomputers. I really enjoyed building the system, and am having even more fun "playing" with it. It was, in short, a valuable learning experience for me—I think it will be for you, too. ■

Ultra Banner

Back in January, we ran an article about the Boston Computer Society and its 15-year-old president, Jonathan Rotenberg. We said we'd be bringing you his banner program. Here it is.

Jonathan Rotenberg, President
Boston Computer Society
17 Chestnut St.
Boston MA 02108

Banner programs fall in between being a game and a practical application. They print large letters on paper and may be used to make signs, messages or, as the title suggests, banners. Banner has appeared in many forms on many computers, printing letters of all shapes and sizes. The program presented herein, "Ultra Banner," is what I consider the ultimate—a program that prints letters of any reasonable size, horizontally or vertically, and gives the user the flexibility to define new letters or symbols.

Different Techniques

Many of the larger banner programs that print the most beautiful letters are quite straightforward. If the user entered an "A" on such a program, for instance, it might have a corresponding series of PRINT statements, as in Fig. 1. Although this type of program can produce elegant character sets, such as script and italic, it is generally very long and lacks the flexibility to print different character sizes.

A largely used technique is to have a series of subroutines, each one defining a segment of a letter. For instance, an "O" can be thought of as a square that can be broken down into a vertical line, two horizontal lines and a second vertical line. If you square off a "C," it can be thought of as a single vertical line and two horizontal lines.

Thus, all that would be necessary to print a big "O" or "C" would be a short program containing two subroutines: one to print a vertical line, the second to print two horizontal lines. When the user enters an "O," the first subroutine is called, then the second, then the first again. For a "C" the first subroutine is called only once, followed by the second.

This technique, although simple with "O"s and "C"s, gets very complicated with letters like "K" and "Z." The "segment definition" technique does produce a fairly nice character set and allows the user to select different character sizes; however, it is generally quite lengthy and still lacks the flexibility to easily define new letters or symbols.

The method I use in "Ultra Banner" is called dot matrix—the same used by many impact and all thermal printers. Essentially, it generates all of the characters on a five by five matrix. By filling in dots on this matrix, the alphabet, numbers and punctuation, plus other symbols, may be produced. For instance, to make an "A" on a five by five matrix, you might fill in the squares (or dots) as shown in Fig. 2a. By replacing each "dot" with the letter "A," you get a "big A" (Fig. 2b).

```
PRINT"        A"
PRINT"       AAA"
PRINT"     AA  AA"
PRINT"    AAAAAAA"
PRINT"  AA        AA"
PRINT"AA            AA"
```

Fig. 1. The direct approach used by many large-banner programs.

```
 AAA
A   A
AAAAA
A   A
A   A
```

Figs. 2a and 2b. The letter "A" on a five by five matrix.

Some of the advantages of dot matrix over other methods are: dots may be any size (to produce any sized letter); the matrix may be turned to sit on the paper in any direction; new matrices may be easily specified (or defined); and the final program is relatively short.

The Program

"Ultra Banner" prints all of the printable characters of the 64 character ASCII subset (uppercase, numbers and punctuation) from a five by five matrix. It will print "big" letters horizontally of regular or double width, "big" letters vertically of any size, messages (standard-sized letters) of normal or double width, and it will allow you to specify matrix patterns for new characters or symbols.

Horizontal printing is accomplished by directly assigning a single letter to each dot on the matrix. For instance, printing a horizontal "A" would produce output identical to Fig. 2b. Double-width characters may also be specified, assuming your printer is capable of printing them. For an 80-column printer, the maximum number of horizontal double-width characters is five; the maximum number of regular characters is 11.

Vertical printing is accomplished by turning the matrix on

```
ULTRA BANNER IS FLEXIBLE
ULTRA BANNER IS FLEXIBLE

U   U  L      TTTTT  RRRR    AAA
U   U  L        T    R   R  A   A
U   U  L        T    RRRR   AAAAA
U   U  L        T    R R    A   A
 UUU   LLLLL    T    R  RR  A   A
```

Sample from Fig. 4 at full size.

its side and making the "dots" any square or rectangular formation of letters. The size of these dots is determined by the program; you merely enter the size, in inches, of the characters. The program will also print a left-hand margin of selectable size, in inches. Because the letters are printed vertically down the page in this mode, the size of the message is limited only to the maximum variable length in your BASIC and how much paper you have left.

Defining new characters has two modes: the matrix mode and the user mode. The matrix mode allows you to enter a matrix pattern (like Fig. 2a) that the computer will code for later use. The user mode allows you to tell the computer with which character the defined pattern will be printed. Whenever the computer encounters the character defined in user mode, it will ask for the matrix code supplied by the matrix mode. At this point the code is entered and the matrix will be enlarged or turned appropriately to match the other letters.

The message option of "Ultra Banner" will print a message horizontally of normal-sized letters. Double-width letters may also be specified with this option.

How to Use It

After you have entered the program, made appropriate changes (see the Making Changes section) and typed 'RUN' the computer will give you a choice of five options: Horizontal, Vertical, Define, Message or Stop. To select an option, type *only* its first letter (e.g., V for Vertical).

If you request Horizontal, the computer will ask if the message should be printed in wide or regular print. If your printer is not capable of printing wide letters, type R. Remember to type only the first letter of the desired option (i.e., W or R). The computer will now request the word you want printed. You may enter as many words, punctuation marks or numbers as desired if the total length does not exceed 11 characters for regular print or five for wide. Longer horizontal messages must be split up over two or more lines.

Requesting Vertical printing will cause the computer to first ask for the dimensions, in inches, of the desired letters in your message. Enter the height, a comma and the width. The computer will now ask for the left-hand margin in inches. If no margin is desired, enter 0 (zero). Finally, the computer will ask for the message which is to be printed. "Ultra Banner" will not check the length of this message.

Because the computer must

```
HORZ., VERT., DEFINE, MESSAGE OR STOP (H/V/D/M/S)? D
DEFINE USER CHARACTER OR DEFINE MATRIX (U/M)? U
WHAT IS THE CHARACTER? *
HORZ., VERT., DEFINE, MESSAGE OR STOP (H/V/D/M/S)? D
DEFINE USER CHARACTER OR DEFINE MATRIX (U/M)? M
ENTER MATRIX USING 1s AND 0s
? 00100
? 01010
? 10001
? 01010
? 00100
MATRIX CODE IS ?.!.?
HORZ., VERT., DEFINE, MESSAGE OR STOP (H/V/D/M/S)? H
WIDE OR REG.? R
WORD? *
MATRIX CODE? ?.!.?
  *
 * *
*   *
 * *
  *
HORZ., VERT., DEFINE, MESSAGE OR STOP (H/V/D/M/S)?
```

Fig. 3. The procedure for defining a new character: Define the user character, then the matrix. The computer supplies the matrix code. Use the horizontal or vertical modes. When the user character is encountered, the matrix code is requested by the computer.

ULTRA BANNER PROGRAM LISTING

```
10 DIM H$(11),H(5),D$(7):LWIDTH 80 E$=CHR$(0)
20 D$(1)="      ,,, ,       *?*?*/4 %>9:$+360-2-,,     000. !!! "
30 D$(2)="5*?*5$$?$$    #!  ?      ##!A$(0.359.$.$$  1&(?.1&1 "
40 D$(3)="&*?AA?0>!>/0>1.?A$$$ 1.1./1/!!,, ,,,, ,$8&!&8 ? ? "
50 D$(4)="#,0,#.1& $?????.1?11>1>1>.101.>111>?0>0??0>00.031 "
60 D$(5)="11?11?$$$??$$4<12<210000?1;55119531?111?>1>00.112-"
70 D$(6)=">1>43.0.!.?$$$$1111.1***$1155*1*$*11*$$$?A$(??!!!?"
80 D$(7)="0($A!?000?$*1  "
90 INPUT"HORZ., VERT., DEFINE, MESSAGE OR STOP (H/V/D/M/S)";Q$
100 IF Q$="V" THEN 260 ELSE IF Q$="D" THEN 450
110 IF Q$="S" THEN END
120 INPUT"WIDE OR REG. (W/R)";Q1$:IF Q1$="W" THEN C=5 ELSE C=11
130 IF Q$="M" THEN 430 ELSE IF Q$="V" THEN 260
140 INPUT"WORD";W$:IF LEN(W$)>C THEN 140
150 FOR X=1 TO LEN(W$):T=ASC(MID$(W$,X,1))-31
160 IF T=ASC(E$)-31 THEN INPUT"MATRIX CODE";H$(X):GOTO 180
170 S=INT((T-1)/10):H$(X)=MID$(D$(S+1),5*T-S*50-4,5)
180 NEXT X:LPRINT:LPRINT CHR$(C-4);
190 FOR X=1 TO 5:FOR Z=1 TO LEN(W$)
200 B=ASC(MID$(H$(Z),X,1))-32:IF B=33 THEN B=2
210 FOR W=1 TO 5:IF B<2↑(5-W) THEN LPRINT" ";:GOTO 230
220 LPRINTMID$(W$,Z,1);:B=B-2↑(5-W):GOTO 230
230 NEXT W:LPRINT"  ";:NEXT Z:LPRINT
240 FOR Z=4 TO 0 STEP -1
250 LPRINT CHR$(C-4);:NEXT X:LPRINT:GOTO 90
260 INPUT"HEIGHT, WIDTH (IN INCHES)",G,W:G=G*2
270 FOR X=1 TO 5:H(X)=0:NEXT X
280 INPUT"LEFT HAND MARGIN (IN INCHES)",M:M=M*10
290 PRINT"ENTER MESSAGE":INPUT M$
300 FOR X=1 TO LEN(M$):T=ASC(MID$(M$,X,1))-31
310 IF T=ASC(E$)-31 THEN INPUT"MATRIX CODE",I$:GOTO 330
320 S=INT((T-1)/10):I$=MID$(D$(S+1),5*T-S*50-4,5)
330 H(1)=0:H(2)=0:H(3)=0:H(4)=0:H(5)=0:FOR Y=1 TO 5
340 D=ASC(MID$(I$,Y,1))-32:IF D=33 THEN D=2
350 FOR Z=4 TO 0 STEP -1
360 IF D>=2↑Z THEN H(Z+1)=H(Z+1)+2↑(Y-1):D=D-2↑Z
370 NEXT Z:NEXT Y:FOR Y=5 TO 1 STEP-1:FOR Z=1 TO W:D=H(Y)
380 LPRINTTAB(M);:FOR U=4 TO 0 STEP-1:IF D>=2↑U THEN 400
390 FOR V=1 TO G:LPRINT" ";:NEXT:GOTO 410
400 FOR V=1 TO G:LPRINT MID$(M$,X,1);:NEXT:D=D-2↑U
410 NEXT U:LPRINT:NEXT Z:NEXT Y
420 FOR Y=1 TO W:LPRINT:NEXT Y:NEXT X:GOTO 90
430 PRINT"MESSAGE":INPUT M$:IF LEN(M$)>INT(C/5)*40 THEN 430
440 LPRINT CHR$(C-4);M$:GOTO 90
450 INPUT"DEFINE USER CHARACTER OR DEFINE MATRIX (U/M)",Q$
460 IF Q$="M" THEN 480
470 INPUT"WHAT IS THE CHARACTER";E$:GOTO 90
480 PRINT"ENTER MATRIX USING 1'S AND 0'S"
490 FOR X=1 TO 5:INPUT H$(X):NEXT X
500 PRINT"MATRIX CODE IS ";:FOR X=1 TO 5:C=0:FOR Y=1 TO 5
510 IF MID$(H$(X),Y,1)="1" THEN C=C+2↑(5-Y)
520 NEXT Y:IF C=2 THEN C=33
530 PRINT CHR$(C+32);:NEXT X:PRINT:GOTO 90
```

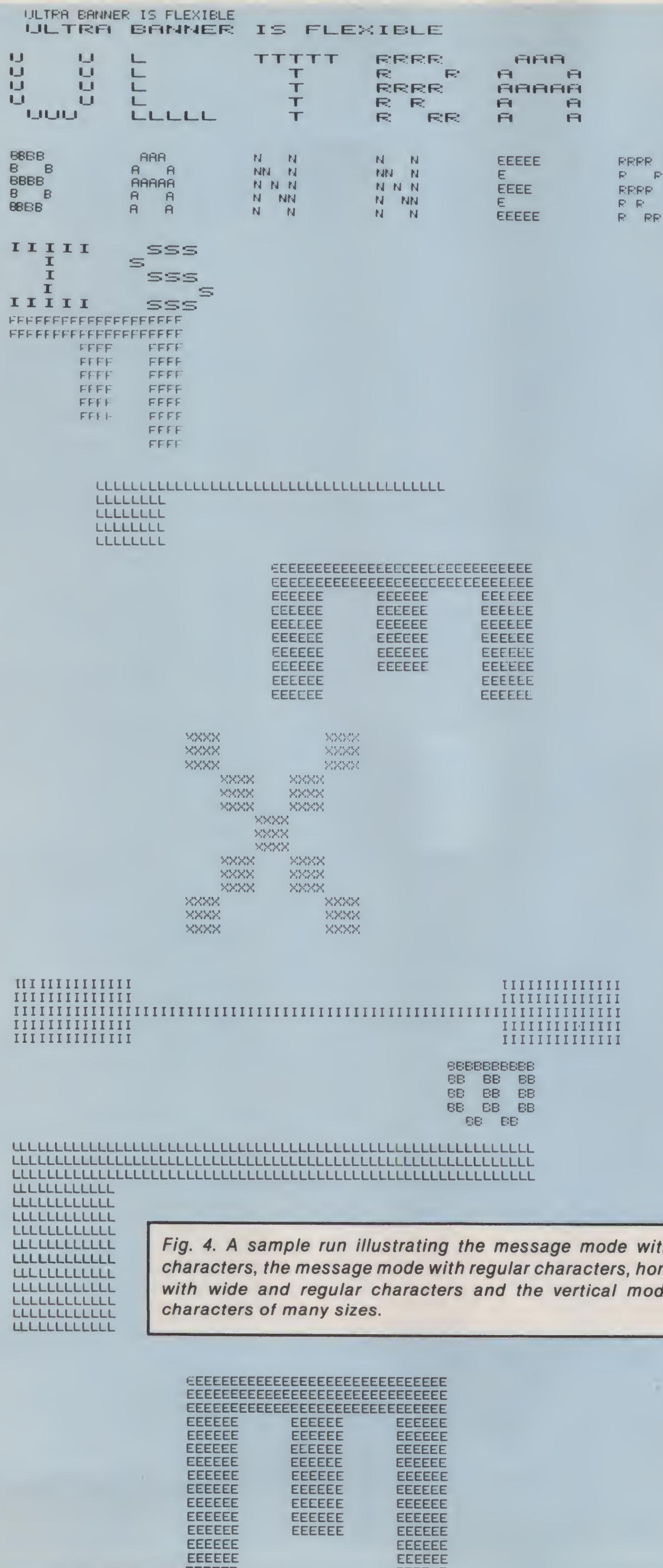


Fig. 4. A sample run illustrating the message mode with wide characters, the message mode with regular characters, horizontal with wide and regular characters and the vertical mode with characters of many sizes.

perform thousands of computations between printing letters in the vertical mode, a pause of several seconds is normal. This pause is due to the process of turning the matrix on its side.

Once in the Define mode, you are given the option of defining a matrix or defining the user character. Defining a matrix is the process of entering a pattern of dots using 1s and 0s. Fig. 2a illustrates the pattern of dots for the letter "A." Defining the user character is how you tell the computer of what character the matrix pattern will be printed. If you were so inclined, for example, you could use this option to print a big "A" made up of "B"s. Fig. 3 illustrates the complete procedure for defining and printing a diamond pattern composed of asterisks.

When the computer gives you the matrix code (see Fig. 3) in the matrix mode, be sure to record it on paper (assuming you are not using a hard-copy terminal). If during either the horizontal or vertical options the computer encounters the user character (* in Fig. 3), it will ask for the matrix code. Enter the code supplied by the matrix mode.

If desired, you may print several defined matrices in one message all composed of the same character. To do this, use the matrix mode to get as many matrix codes as needed. Wherever you would like one of the matrices to appear in your horizontal or vertical message, enter the user character (* in the example). Every time the computer comes to one of these, it will request the code. You may enter a different code each time, thus producing as many matrices as desired. It is easiest to understand this concept by experimenting with it.

The Message option is particularly useful if the program is run on a CRT with a separate printer. After you select this option, the computer will ask whether wide or regular print is desired. Type R or W. When you press 'RETURN' a message of up to 80 characters may be entered for regular *print or 40* for wide. The message will then be printed directly.

To stop the program, the Stop option should be selected. This option will return you to the BASIC command mode.

Making Changes

I developed "Ultra Banner" using TDL 8K BASIC, Version 1.1. With this BASIC, the program and variables occupy less than 2K bytes of memory. I took advantage of several TDL features that are not available on all BASICs. Most of these are minor, though, and should be fairly easy to convert for compatibility.

LWIDTH in line 10 specifies the width of the printer line. This statement was necessary because TDL BASIC assumes a printer width of 72 columns. In most cases this statement may be omitted.

Many INPUT statements have messages in quotations. With some versions of BASIC, statements such as INPUT "MARGIN"; M would have to be changed to PRINT"MARGIN";: INPUT M.

The ELSE statement is used at lines 100, 120 and 130. If your BASIC is not equipped with this statement, replace it at lines 100 and 130 with colons (:) and change the end of line 120 to: THEN C=5: GOTO 90. It will also be necessary to add a new line: 125 C=11.

LPRINT is used whenever banner output (versus a question) is printed. With TDL BASIC, this statement diverts output from the CRT to the printer. Some versions of BASIC use statements such as SELECT, SWITCH or LPRINTER to perform this function. Check your BASIC user manual.

If you are using the program from a teletypewriter-type terminal with no CRT, change all of the LPRINTs to PRINTs. When "Ultra Banner" asks a question, roll the paper down so that all of the questions and answers will be at the top. Roll the paper up for banner output so that questions won't mess it up.

Expanded (or wide) print is accomplished in a rather sneaky way in "Ultra Banner." I use the program with a Practical Automation DMTP-6 uP printer (the same used by The Digital Group), which expands the current line of print upon receiving an ASCII 1 (SOH). When you select wide or regular print, the computer determines the maximum number of horizontal characters that may be printed (five for wide print, 11 for regular). It will always start a line by printing the ASCII value of this number minus four. Since the printer ignores ASCII 6 (ACK), this technique works efficiently. If your printer handles expanded printing in a different way, changes must be made at lines 180, 250 and 440.

To separate multiline statements, some BASICs use the backslash (\) rather than the colon (:). Unlike some banner programs, "Ultra Banner" was designed to be usable with a minimum amount of effort with versions of BASIC that don't offer multiline statements. To do this, divide all of the multiline statements as you type them in. For instance, line 380 presently reads: 380 LPRINT TAB(M);:FOR U=4 TO 0 STEP −1:IF D>=2↑U THEN 400. This line would have to be changed to:

```
380  LPRINT TAB(M);
383  FOR U=4 TO 0 STEP -1
386  IF D>=2↑U THEN 400
```

Conclusion

"Ultra Banner" offers an extremely high degree of flexibility. As you use it, you will discover interesting ways to combine the different character sizes to produce output like that in Fig. 4. You should also find many applications for this all-purpose program.

If you don't have access to a machine with BASIC, but do have access to a Texas Instruments SR-52, you can still enjoy a banner program. "Banner for the PC-100" is a shortened version of "Ultra Banner" available from Professional Program Exchange 52, PO Box 53, Lubbock TX 79408, for $3. Order number 900052. A similar program is also available for the TI-59. ■

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Teletype's KSR-43

Teletype's Model 43 data terminal gets thumbs up from down under.

I believe that most readers of *Kilobaud* have seen the recent advertisements for the new Teletype data terminal, the KSR-43, and have wondered just what design features are incorporated.

Recently, the company for which I work needed an economical printing terminal for microprocessor development work . . . and needed it fast! The local ITT company had ordered a trial batch of KSR-43 terminals which were scheduled for delivery immediately prior to Christmas, so they got the order, sight unseen, on the strength of a Xerox copy of a brochure! Needless to say, that wasn't too much of a risk with a Teletype product, but we were anxious to evaluate the machine when it arrived.

The Teletype KSR-43 send/receive terminal is like none of its predecessors from the stable of the Teletype Corporation. The gold-wire contact keyboard, the noisy rotating typehead and the complicated cranks, levers and clutches have been replaced by an up-to-the-minute solid-state keyboard and a dot-matrix impact printer, all controlled by low-power CMOS ICs.

For the KSR-43 user, this means a light, quiet, low-power and fast terminal for applications requiring hard copy and when it might be difficult to justify the expense of both a CRT terminal and a printer. In mid-1978, the Teletype Corp. (5555 Touhy Ave., Skokie IL 60077) released a paper tape punch and reader to provide KSR-43 users with a means of recording and playing back data. Speed is selectable for 10 or 30 cps. However, any microprocessor enthusiast with cassette or floppy-disk data-storage equipment would probably only require paper-tape equipment occasionally (for input of tapes from software suppliers), and would find one of the inexpensive optical reader kits adequate.

First Impressions

My first, pleasing impressions on unpacking the KSR-43 were its light weight (around 30 lbs.) and clean, functional styling. The unit is very slim and, apart from the power supply casing, which projects slightly at the rear, is not much bigger than a portable typewriter. The lower part of the case is a heavy-walled glossy-black

polystyrene molding, while the top cover is cream colored, with a wrinkle-embossed surface. The operating controls and keytops are black, with double-shot molded white lettering.

Although we had a natural impatience to get power onto our new terminal, we read the unpacking instructions before connecting to the wall socket. It was necessary to remove a cardboard packer from the printer mechanism and, being factory fresh, the terminal was outfitted with ribbon cartridge before use.

This is a very easy operation and, big surprise, it is the first machine I have ever been able to fit a ribbon on without getting my hands dirty. (I recall one printer manufacturer who was so convinced that ribbon changing had to be a dirty job that he supplied a pair of disposable plastic gloves with each replacement ribbon. That is a thing of the past with the KSR-43.)

The Controls

Immediately above the keyboard, a row of push buttons and indicators provides most of the operator controls required in normal use. At the extreme right of this row, a push button controls the data-transmission rate, either 10 characters per second (110 baud) or 30 per second (300 baud). On local loop, you will find that the KSR-43 types at a maximum rate of about 50 characters per second. However, in the data-transmission mode, the characters are buffered and are sent or received at the selected rate.

At first, when I noticed the relatively slow rate of the carriage return, I assumed that it would be necessary to provide a software delay during printout in order to avoid printing characters while the carriage return was taking place. (This does happen with other Teletype machines; the cure is to output four or five ASCII null characters after the carriage return.)

The KSR-43 does not require such a delay since any characters received during the carriage return are stored in a line buffer, and printing of the new line starts only when the printer is ready. At the beginning of the line, the characters are output from the buffer at the maximum rate (50 per second), and the printer soon makes up for the time lost during the carriage return.

The next push button enables selection of half duplex (echo on) or full duplex (echo off), which is a useful panel control if you use the terminal on an unfamiliar type of microprocessor. Next, there is a control that enables or disables parity on received data. In most microprocessor systems, the output parity bit is a logic zero, and you must disable the parity check at the terminal or default characters will be printed.

The innermost push button on the right-hand side is labeled PRINTER TEST and, so long as this is depressed, the KSR-43 will continuously print lines containing its whole set of characters at a rate of 50 characters per second. In the event of problems in the initial connection of your KSR-43, this is a comforting facility. It's also very handy if you need to convince the head of the house that your expensive new terminal is a little more versatile than a Sears Roebuck typewriter.

The two main controls, on the row of controls above the keyboard at the left-hand side, are the LOCAL and TERM READY push-button switches, which, respectively, select local loop or the data-transmission mode. In local loop operation, the keystrokes are printed, as they would be on a typewriter, but data may be neither received nor transmitted over the line. To communicate with your computer, the TERM READY switch must be pressed.

During use, if you have a fault condition that latches up the KSR-43, the INTRPT or interrupt lamp will light and should be reset by depressing the button. The remaining two keytops, labeled DATA and ALARM, are indicators only. In normal operation, the DATA indicator will flicker on spacing pulses. The ALARM indicator will light if you depress the printer test button, lift the lid or run out of paper.

View with top cover removed showing keyboard and print mechanism. The printhead is at top left and is traversed by the spiral lead screw. The traverse drive motor can be seen top right under the platen.

The Keyboard and Printer

The keyboard layout of the new terminal is a little different from that of earlier Teletype machines, even when compared with the KSR-38 (which was the previous upper/lowercase ASCII device). To the operator, perhaps the most significant change is the provision of a latching CAPS LOCK key and of REPEAT and BACK SPACE keys.

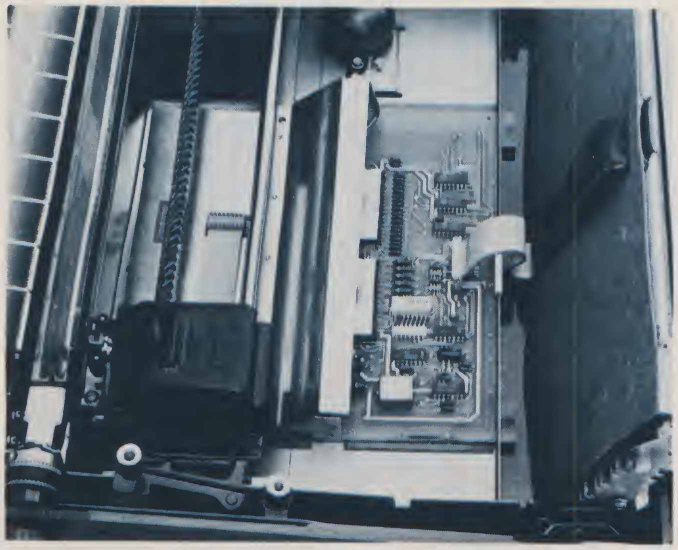
When the CAPS LOCK key is depressed, all keyboard alpha characters are output as ASCII uppercase codes, while the operation of the shift key on numeric and punctuation characters is unchanged. The REPEAT key is very useful, particularly for such jobs as underscoring headings; if you wish to page up quickly on the KSR-43, just press the LINE FEED and the REPEAT keys simultaneously.

Operation of the keyboard can best be described as positive, but sensitive, and is very much like that of a golf ball (Selectric) typewriter. If you are a two-finger typist like me, you will need to develop a fair degree of accuracy or you will find a great many unwanted characters in your work. Certainly, any comparison with earlier Teletype keyboards is quite pointless, but once you have become accustomed to the KSR-43 keyboard action you will wonder how you ever managed on one of those marvelous, slow, clunking devices.

The left-hand and right-hand margins are set from the keyboard. Simply position the printhead where you wish to set up the margin and type ESC, followed by a lowercase l for left-hand or r for right-hand. Both margins are cleared by typing ESC and a lowercase x. Note that the machine should be in the local loop mode while setting or clearing margins.

In standard form, the KSR-43 prints 132 characters per line on 12-inch-wide sprocket-feed paper, but it may be set to print lines of 72 or 80 characters. According to the manufacturer's leaflet, the KSR-43 will handle form sets with up to two carbons.

The KSR-43 is not fitted with any forms-control mechanism, which means that your software will have to keep count of lines printed if you wish to use it for a formatted job, such as invoice printing, where you need to page up properly. Since the line-feed mechanism seems to be driven by a stepper motor, my guess is that the Teletype design team will soon



Internal view with keyboard hinged up, giving access to the main logic control board.

introduce a simple, pulse-counting forms controller.

As with any other dot-matrix printer, the printhead of the KSR-43 covers up the area being typed . . . a serious problem in a terminal because it prevents the operator from viewing the character just entered. Teletype's method of overcoming this difficulty is to move the printhead by one position to the right if no character has been printed within the last second, thus allowing the operator to read all the characters entered. As soon as a new character is received, the printhead moves back to its correct position, and prints. This movement of the head is a little unnerving if you are a look-and-peck typist, but you will soon get used to it.

Internally Selectable Options

In addition to the control features provided on the front panel of the KSR-43, several options are user-selectable on an internal DIP switch. Access to the switch is gained by swinging the unit top cover and the keyboard assembly upward. Before the keyboard assembly can be swung upward, it is necessary to loosen a securing screw at each side.

Using the selectable options, it is possible to modify the printed characters for the zero, the vertical arrow and the underscore. Line length is also selectable for 132, 72 or 80 characters.

The keyboard generates even parity under normal conditions, but may be set so that the parity bit is permanently logic level one. It is normal practice to reset the parity bit to the 0 state within the microprocessor system, and this is generally done in software as part of the console input routine. Note, however, that some systems may rely upon the keyboard to zero the parity bit and that the KSR-43 will not do this.

Other DIP switch facilities allow for optional carriage return/line feed at the end of a line and for auto-disconnect from the line upon receipt of an EOT (end-of-transmission) character. (This last facility is required for line communications but is not required for use as a microprocessor terminal.)

General Arrangement and Connection

As the photographs show, the internal layout of the KSR-43 is extremely clean and uncluttered. The printed-circuit keyboard encoder is mounted underneath and forms part of the keyboard assembly, which connects into the rest of the machine with a flat cable and plug. The printer control electronics are contained on a small printed-circuit board that mounts in the base of the unit, underneath the keyboard assembly. The power supply and the interface circuit are housed at the rear.

The unit we ordered has the RS-232 interface option, which I prefer for microprocessor work. It comes equipped with a standard 25-pin miniature plug (advertised by several suppliers in *Kilobaud*) so that, in most cases, you will need to provide an interconnecting cable with a 25-pin socket at one end and a 25-pin plug at the other. Data out from the KSR-43 is on pin 2, data in should go to pin 3 and the signal ground is on pin 7. In order to satisfy the handshake and interlock requirements of the RS-232 interface, strap together and connect pins 5, 6, 8 and 20 to a source of + 12 V dc.

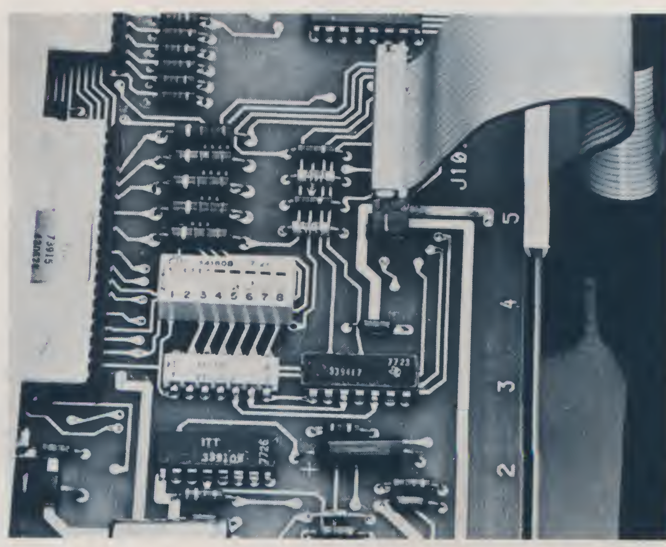
Switch on your computer, power up the terminal, depress the TERM READY switch and you should be ready to work at either 110 or 300 baud.

Overseas users will be pleased to hear that the KSR-43 is suitable for operation on either a 50 Hz or 60 Hz supply at a nominal 115 V. If you need to provide an external transformer to suit a different supply voltage, a rating of 100 Watts should be sufficient as the specified fuse rating for the KSR-43 is 1 A. I suppose that one day more manufacturers will ensure that their equipment can operate on overseas electricity supplies and so make life easier for export customers who are on 50 Hz mains. (Of course, any manufacturer who provides dual 115/230 V, 50/60 Hz operation must surely score on export markets. A surprising number of American microprocessor system designers have realized this.)

In the limited amount of use which I have given the KSR-43 I have only found two bad points. First, the paper size is yet another special (12 inches wide, with the same-specification sprocket holes as the ASR-33 stationery), so make sure that if you order a KSR-43 you include an initial supply of paper on your order.

Second, the unit I have used suffers from a minor variation in the speed of traverse of the printhead . . . normally not objectionable unless the option to print zero with a diagonal slash has been selected. I believe that this fault is the result of backlash between the printhead and the lead screw which drives it, and as such will be fixed by adjustment at the first service call. If you do not select the option to print the zero with a slash, then this fault *will* go unnoticed.

My overall impression of the KSR-43 is that it is a most attractive and serviceable machine, very competitive in the new-equipment market and ideal for those who need a no-fuss upper/lowercase printing terminal with legible print characters and moderate speed. ■



Close-up of logic control board showing the internal DIP switch used for user-function selection.

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The program was the result of a specific problem that arose in my company. Our busy season was coming up, and, with a product line in excess of 200 items, I needed to get estimates of what I could expect to sell during this time of the year. The need was especially great for the 50 or so items that required parts with a four-to-six-week delivery time.

In the past, someone had visually scanned the month-by-month sales of previous years and made item-by-item estimates. The results were fairly accurate, but the job was time-consuming and could only be done by one or two people with the experience and "feel" for the numbers. It was also a job that needed constant, monthly updating, which became very tedious.

The company has an in-house DEC PDP 8 that was dedicated to order processing and receivables. (It also uses Dibol, a DEC proprietary language with which I am not familiar.) It was obvious that our computer would not be any help.

At this time I finally got my Radio Shack 4K, Level I TRS-80. I decided to write a forecasting program to solve the company's problem and also to become familiar with TRS-80 BASIC. I wrote the program in Level I and then converted it to Level II. As written, it should be compatible with almost all BASICs; it is easily converted to Level I.

The Program

To use this forecasting method, you need a minimum of 13 months of data—12 months of history and at least one month of the new period. Bear in mind that the more months of data you have for the new period, the more reliable the forecast will be.

The best way to describe the concept of the "1 Percent Method" is to consider the example in Table 1. In this example we show 14 months of data—the full year of 1977 and two months of 1978. We want the estimate of sales for 1978 in total and by month.

The program will first divide each of the 1977 sales figures by the total for the year and store these computations in A (61-72). It will then total the 1978 sales (in this case January and February) and divide this total by the cumulative history computed figures for the same period of the history year (January and February 1977):

Jan 1977 10/160	=	.0625
Feb 1977 12/160	=	.0750
TOTAL		.1375

Jan & Feb 1978 Sales = 25.
25/.1375 = 181.8,
which is the estimate for the year of 1978.

The stored 1977 percentage figures are then multiplied by the total year estimate to arrive at monthly totals. The estimates shown in the example are rounded. When you run the program they will not be rounded, since a rounding routine and/or print formatting takes up too much memory.

The program allows for three history years to smooth out any aberrations that may exist in a given year, but if data is not available for the first two years, you can skip over them. As stated above, you must have at least 12 months of history data to use this method.

Whatever method is used in forecasting, intelligent input

Month	1977 Sales	1978 Sales		1978 Projection*
JAN	10	11	1st 2 months	25.
FEB	12	14		
MAR	14	-		15.9
APR	8	-		9.1
MAY	16	-		18.2
JUN	7	-		8.0
JUL	9	-		10.2
AUG	12	-		13.6
SEP	14	-		15.9
OCT	20	-		22.7
NOV	27	-		30.7
DEC	11	-		12.5
Total	160	25		181.8

*For presentation, these figures are rounded.
They are not rounded by the program due to memory limitation.

Table 1.

from the user as well as the mathematical computations are needed. If Easter was in March in 1977 and in April in 1978, you must adjust your estimates to take this into account . . . probably in every business, but most certainly in any business that relates to retailing. You must also consider if a specific item was promoted during a period. You know your own business and forecasting needs, so apply your knowledge to the estimates derived from the program.

Data entry is screen prompted and relatively easy, but beware of entry errors. There is no entry correction routine in order to keep the program within the capabilities of 4K machines. For the same reason, there are also no remarks, no spaces between variables, commands, etc.

Program Hints

Program 1 is the entry program as described above. There is an error routine in lines 310 and 315 that is included to avoid the possibility of your getting wrong estimates. If the program is entered correctly, this routine should never be used. The program also allows for data storage on tape. The output to tape routines varies for different equipment, and you will have to rewrite these lines to conform to your BASIC.

Program 2 is used for updating the data file if you plan to add new data each month. The more current period data you use for the forecast, the more reliable it becomes. Updating can be very tedious if you only have one cassette recorder . . . you will constantly be replacing tapes going from input to output.

If you have the capacity for two recorders there is no problem. If not, you can build a very simple DPDT switch box to control the remotes of the two recorders and hook one recorder to play and one to record, both controlled by the remote switch. Attach the plug normally going to the "earphone" input to the same input on the one set up for Play and attach the plug normally going to the AUX input to the one set up for Record.

The only thing you have to remember is to switch from Record to Play as the program prompts request. It's also a good idea not to record on the original data tape until after you have used and verified the new one. While this means that you will need three tapes (original, new and the one created from the new one), anyone who has lost data files due to a bad tape or bad recording will understand and agree with this precaution.

The TRS-80 output to tape routine can be a real tape and time waster due to its structure. The statements in lines 480-500 are handled as they are to minimize these problems. A For-Next loop would look more efficient, but it would use about ten times as much tape and take at least ten times longer.

As I stated earlier, this program was converted from Level I to Level II. Radio Shack Level I permits only one array, A(N), and this was followed through in the finished program. Four conventions unique to the TRS-80 are used: (1) CLS clears the screen; (2) * in an IF statement is the same as "and"; (3) + is the same as "or"; (4) check your input from tape and output to tape.

To use this program for Level

A (1-12)	1975 Data (history)
A (13-24)	1976 Data (history)
A (25-36)	1977 Data (history)
A (37-48)	1978 Data (current period)
A (49-60)	Monthly totals for the history years
A (61-72)	Monthly percentages for the history years (A (49-60)/Q)
A (73-84)	Monthly estimates for 1978
L	Cumulative 1975 total
M	Cumulative 1976 total
N	Cumulative 1977 total
P	Cumulative 1978 total
Q	Total of 1975 through 1977
R	Item number
S	Number of data months for 1978
T	Cumulative history percentages
U	Cumulative history percentages for "S" months
W	Estimate for the entire year

Table 2. Variables listing.

```
1 DIMA(84)
2 DEFINTI
3 CLS:PRINT"      1% FORECASTING PROGRAM":PRINT:PRINT
5 PRINT"ENTER SALES BY MONTH FOR THE YEARS OF 1975,1976,1977."
6 PRINT"IF THERE ARE NO SALES FOR 1975 OR 1976 ENTER A NEGATIVE"
7 PRINT"NUMBER TO GO TO 1977.  YOU NEED AT LEAST ONE 'HISTORY'"
8 PRINT"YEAR FOR THIS FORECASTING METHOD TO WORK.  OF COURSE,"
9 PRINT"YOU ALSO NEED CURRENT YEAR DATA(1978).":PRINT:PRINT
12  INPUT"ITEM NUMBER ";R
13  L=0:M=0:N=0:P=0:T=0:U=0:Q=0:W=0
15  FORI=1TO84:A(I)=0:NEXTI
17  PRINT"IF NO ENTRY FOR 1975 ENTER A NEGATIVE NUMBER."
20  FORI=1TO12
30  GOSUB5000
35  PRINT"1975 ";
40  INPUTA(I)
42  IFA(I)<0THENA(I)=0:GOTO65
50  L=L+A(I)
60  NEXTI
65  PRINT"IF NO ENTRY FOR 1976 ENTER NEGATIVE NUMBER."
70 FORI=13TO24
75 GOSUB5000
77 PRINT"1976 ";
80 INPUTA(I)
90  IFA(I)<0THENA(I)=0:GOTO110
100  M=M+A(I):NEXTI
110  PRINT"ENTER 1977 DATA.":PRINT
115  FORI=25TO36:GOSUB5000
120  INPUT"1977 ";A(I)
130  N=N+A(I):NEXTI
140  INPUT"NUMBER OF MONTHS FOR WHICH YOU HAVE 1978 DATA ";S
142  IFS>12THEN140
143  IFS<1THEN140
145  PRINT:PRINT"ENTER 1978 DATA ":PRINT
150  FORI=37TO(S+36):GOSUB5000
160  INPUT"1978 ";A(I)
170  P=P+A(I):NEXTI
200  A(49)=A(1)+A(13)+A(25):A(50)=A(2)+A(14)+A(26)
210  A(51)=A(3)+A(15)+A(27):A(52)=A(4)+A(16)+A(28)
220  A(53)=A(5)+A(17)+A(29):A(54)=A(6)+A(18)+A(30)
230  A(55)=A(7)+A(19)+A(31):A(56)=A(8)+A(20)+A(32)
240  A(57)=A(9)+A(21)+A(33):A(58)=A(10)+A(22)+A(34)
250  A(59)=A(11)+A(23)+A(35):A(60)=A(12)+A(24)+A(36)
260  Q=L+M+N
270  FORI=49TO60
280  A(I+12)=A(I)/Q
290  NEXTI
310  FORI=61TO72:T=T+A(I):NEXTI:IF(T<.997)+(T>1.003)THENPRINT"ERROR"
315  IF(T<.997)+(T>1.003)THENSTOP
320  FORI=61TO60+S:U=U+A(I):NEXTI
330  W=P/U
335  FORI=(60+S)TO72
340  A(I+12)=A(I)*W
360  NEXTI
370  CLS:PRINT"     THE MONTHLY ESTIMATES ARE ":PRINT
375  PRINT"MONTH","ESTIMATE"
377  PRINT"1ST ";S;" MONTHS",P
380  FORI=(S+1)TO12
390  GOSUB6000
400  PRINTA(I+72)
410  NEXTI
430  PRINT:PRINT"TOTAL",W:V=0
440  INPUT"TO SAVE DATA ENTER '1' ";V
450  IFV<>1THEN12
460  PRINT"PUT CASSETTE ON RECORD "
470  INPUT"HIT ENTER TO SAVE DATA ";A$
480  PRINT#-1, R,S,P,A(61),A(62),A(63),A(64)
490  PRINT#-1, A(65),A(66),A(67),A(68),A(69),A(70)
500  PRINT#-1, A(71),A(72)
510  PRINT"DONE":FORI=1TO500:NEXTI:CLS:GOTO12
4990  END
5000  IF(I=1)+(I=13)+(I=25)+(I=37)THENPRINT"JANUARY    ";
5001  IF(I=2)+(I=14)+(I=26)+(I=38)THENPRINT"FEBRUARY   ",
5002  IF(I=3)+(I=15)+(I=27)+(I=39)THENPRINT"MARCH      ";
5003  IF(I=4)+(I=16)+(I=28)+(I=40)THENPRINT"APRIL      ";
5004  IF(I=5)+(I=17)+(I=29)+(I=41)THENPRINT"MAY        ";
5005  IF(I=6)+(I=18)+(I=30)+(I=42)THENPRINT"JUNE       ";
5006  IF(I=7)+(I=19)+(I=31)+(I=43)THENPRINT"JULY       ";
5007  IF(I=8)+(I=20)+(I=32)+(I=44)THENPRINT"AUGUST     ";
5008  IF(I=9)+(I=21)+(I=33)+(I=45)THENPRINT"SEPTEMBER  ";
5009  IF(I=10)+(I=22)+(I=34)+(I=46)THENPRINT"OCTOBER    ";
5010  IF(I=11)+(I=23)+(I=35)+(I=47)THENPRINT"NOVEMBER   ";
5011  IF(I=12)+(I=24)+(I=36)+(I=48)THENPRINT"DECEMBER   ";
5020  RETURN
6000  IFI=1THENPRINT"JANUARY",
6001  IFI=2THENPRINT"FEBRUARY",
6002  IFI=3THENPRINT"MARCH",
6003  IFI=4THENPRINT"APRIL",
6004  IFI=5THENPRINT"MAY",
6005  IFI=6THENPRINT"JUNE",
6006  IFI=7THENPRINT"JULY",
6007  IFI=8THENPRINT"AUGUST",
6008  IFI=9THENPRINT"SEPTEMBER",
6009  IFI=10THENPRINT"OCTOBER",
6010  IFI=11THENPRINT"NOVEMBER",
6011  IFI=12THENPRINT"DECEMBER",
6012  RETURN
```

Program 1.

```
10  CLS:PRINT"        PROGRAM 2.  UPDATE OF 1% FILES. ":PRINT:PRINT
15 DIMA(84)
20  PRINT"YOU WILL BE RECALLING R (ITEM #), S (NUMBER OF 1978 MONTHS"
30  PRINT"PREVIOUSLY ENTERED), P (THE CUMULATIVE TOTAL OF 1978"
40  PRINT"DATA ENTERED) AND A(61)-(72) (THE MONTHLY PERCENTFGES"
45  PRINT"PREVIOUSLY COMPUTED). "
50  R=0:S=0:P=0:U=0:W=0:FORI=1TO84:A(I)=0:NEXTI:PRINT
55  INPUT"LOAD 1% FILE TAPE AND HIT ENTER WHEN READY ";A$
60  INPUT #-1, R,S,P,A(61),A(62),A(63),A(64)
65  INPUT #-1, A(65),A(66),A(67),A(68),A(69),A(70)
70  INPUT #-1, A(71),A(72)
80  CLS:PRINT"ITEM NUMBER.....";R;"     .....";S;" MONTHS ALREADY ENTERED. "
90  INPUT"HOW MANY ADDITIONAL MONTHS ARE YOU ENTERING ";B
100  IF(B<1)+((B+S)>12)THEN90
110  PRINT"ENTER ADDITIONAL 1978 DATA. ":PRINT
120  S=S+B
130  FORI=(S-B+37)TO(S+36):GOSUB5000
140 INPUT"1978";A(I)
150  P=P+A(I):NEXTI
170 FORI=61TO(60+S):U=U+A(I):NEXTI
180  W=P/U
190  FORI=(60+S)TO72
200  A(I+12)=A(I)*W
210  NEXTI
220  CLS:PRINT"         THE MONTHLY ESTIMATES ARE:":PRINT
230  PRINT"MONTH","ESTIMATE"
240  PRINT"1ST. ";S;" MONTHS",P
250  FORI=(S+1)TO12
260  GOSUB6000
270  PRINTA(I+72):NEXTI
280  PRINT:PRINT"TOTAL",W:V=0
290  INPUT"TO SAVE DATA ENTER '1'";V
300  IFV=1THEN320
310  CLS:GOTO50
320  PRINT"PUT NEW DATA TAPE ON AND PUT CASSETTE ON RECORD. "
330  INPUT"HIT ENTER TO SAVE DATA. ";A$
340  PRINT#-1, R,S,P,A(61),A(62),A(63),A(64)
350  PRINT#-1, A(65),A(66),A(67),A(68),A(69),A(70)
360  PRINT#-1, A(71),A(72)
370  CLS:PRINT"DONE":FORB=1TO500:NEXTB:CLS:GOTO50
380  END
5000  IFI=38THENPRINT"FEBRUARY  ";
5001  IFI=39THENPRINT"MARCH     ";
5002  IFI=40THENPRINT"APRIL     ";
5003  IFI=41THENPRINT"MAY       ";
5004  IFI=42THENPRINT"JUNE      ";
5005  IFI=43THENPRINT"JULY      ";
5006  IFI=44THENPRINT"AUGUST    ";
5007  IFI=45THENPRINT"SEPTEMBER ";
5008  IFI=46THENPRINT"OCTOBER   ";
5009  IFI=47THENPRINT"NOVEMBER  ";
5010  IFI=48THENPRINT"DECEMBER  ";
5020  RETURN
6000  IFI=2THENPRINT"FEBRUARY",
6001  IFI=3THENPRINT"MARCH",
6002  IFI=4THENPRINT"APRIL",
6003  IFI=5THENPRINT"MAY",
6004  IFI=6THENPRINT"JUNE",
6005  IFI=7THENPRINT"JULY",
6006  IFI=8THENPRINT"AUGUST",
6007  IFI=9THENPRINT"SEPTEMBER",
6008  IFI=10THENPRINT"OCTOBER",
6009  IFI=11THENPRINT"NOVEMBER",
6010  IFI=12THENPRINT"DECEMBER",
6020  RETURN
```

Program 2.

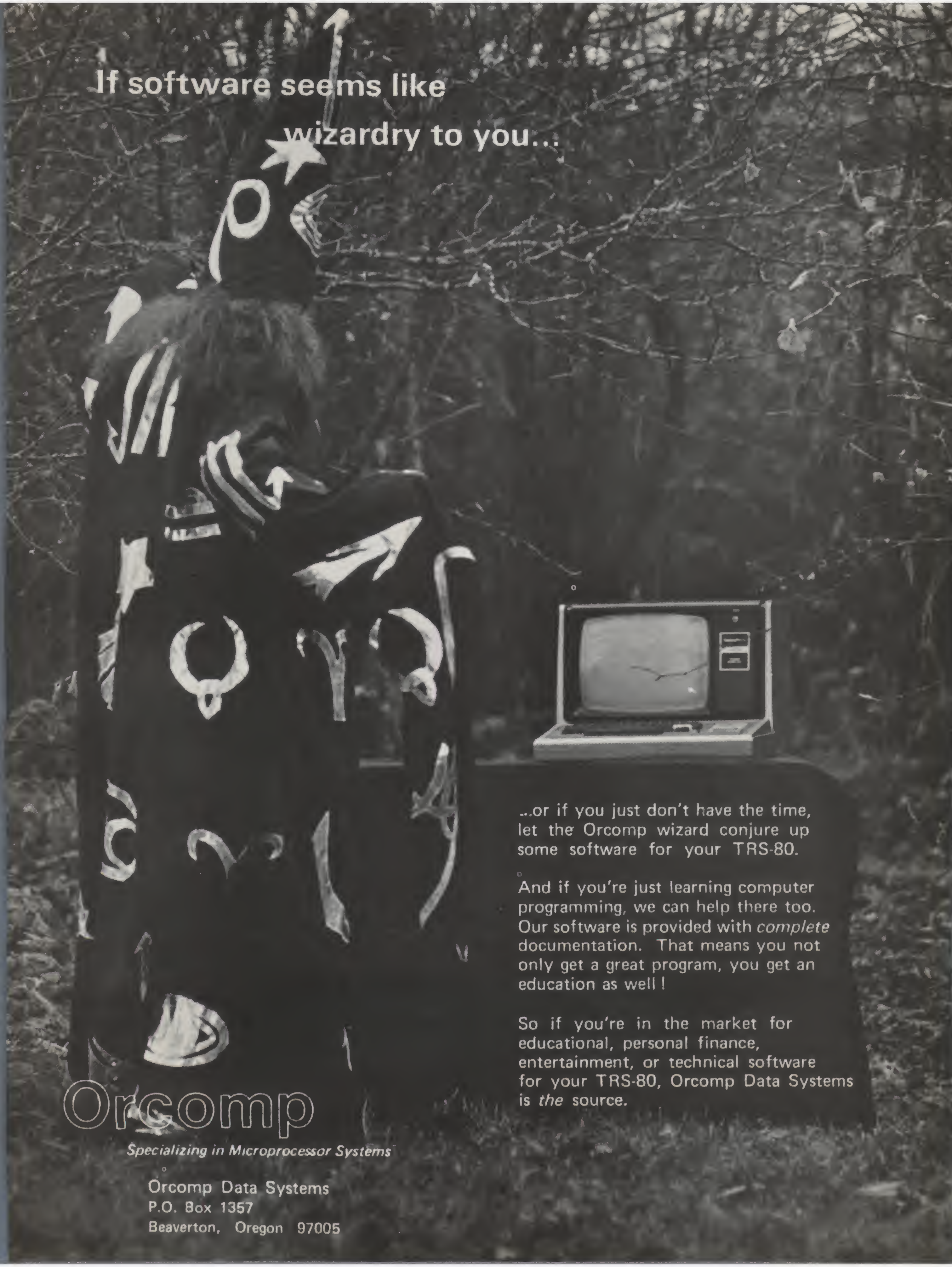
I, full use must be made of all abbreviations for the program to fit in 4K. You may also have to abbreviate the months to three letters, depending upon how efficiently you utilize the abbreviations. Also eliminate lines 1 and 2 (DIM and DEFINT statements) and redo the PRINT # and INPUT # statements.

The program can be updated annually by changing the years in lines 35, 77, 120 and 160. If you use a fiscal period, rearrange the months in lines 5000 to 5011 and lines 6000 to 6011. Make the changes in both programs.

Due to the 4K self-imposed limitation and the slowness of the TRS-80 data storage, the actual input data for the individual months for each year are not saved so that at the beginning of each year you must enter the history data again. The fix for this can become complicated, since the monthly data must be saved for the history years as well as each month entered for the forecast year. The only real solution is a floppy, but that is next year's project.

The 1 percent forecasting procedure is certainly not the most sophisticated method of forecasting. Large companies have entire departments devoted to sales projections and forecasting, using many kinds of economic data and mathematical methods. Used judiciously and with a full awareness of its limitations, this method can be very effective as a guide and tool in your short-range forecasting needs. ■

Reader Service—see page 179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Too Many Variables?

This memory aid will help you manage an overabundance of variables.

Robert C. A. Goff
Berkeley Perinatal Data
PO Box 5231
Berkeley CA 94705

One of the chronic problems with BASIC had been its shortage of available variable names. However, with the more powerful BASICs now on the market, the number of available variable names has increased and presents the opposite problem — you can lose track of them while writing a lengthy program. The problem can, of course, be easily solved by simply writing, on a scrap of paper, the variable names that have already been used; but it is the rare computer hobbyist who practices such discipline.

A practical remedy is presented by J. S. Coan in his book *"Advanced Basic: Applications and Problems,"* published by Hayden Book Company, 1976 (see Appendix D: "A Programmer's Aid"). Coan's short program generates a list of all possible numeric variables, and a few of the possible string and array variable names.

Using his concept, I have put together a short program that will generate a list of all possible numeric, string and array variable names available in North Star BASIC, with spaces for noting the dimensions used. The programmer may then simply circle each variable as it is used, and if dimensioned, note its dimensions. It's really very handy.

The listing (Program A) will print a continuous list on 8½-inch paper, either roll or fan-fold. If you prefer to print the entire list in three pages of full 128-column width paper (as shown in the program run), then the following changes are necessary: Delete lines 240, 270, 280, 290, 360, 390, 400, 410; and add or modify the lines in Example 1.

In North Star BASIC, PRINT#1, and LINE#1, apply to PRINT and LINE length on the #1 serial I/O port used for the printing device.

Although such a list of variable names is not worth the effort for small programs, you will find that it helps to prevent multiple use of the same name in large programs. Give it a try; it's not very sophisticated, but it works. ■

```
12 REM CAUTION ! LINE IS 128 CHARACTERS LONG
88 LINE#1,128
210 FOR X=1 TO 12\PRINT#1,\NEXT
330 FOR X=1 TO 14\PRINT#1,\NEXT
```

Example 1.

```
10 REM **************** VARIABL3 ********************************
20 REM *** THIS WILL PRINT A LIST OF ALL POSSIBLE *************
30 REM *** NUMERIC, ARRAY, AND STRING VARIABLES ALLOWED IN ****
40 REM *** NORTH STAR BASIC.  WRITTEN BY ROBERT C.A. GOFF *****
50 REM *** CONCEPT FROM "ADVANCED BASIC", BY J.S. COAN, *******
60 REM *** HAYDEN BOOK COMPANY, ROCHELLE PARK , NEW JERSEY ****
70 REM *** 1976 ***********************************************
80 REM
90 DIM A$(26),B$(10)
100 A$="ABCDEFGHIJKLMNOPQRSTUVWXYZ"
110 B$="0123456789"
120 PRINT#1,"PROGRAM                    DATE                    PROGRAMMER"
130 PRINT#1,
140 FOR X=1 TO 26
150 PRINT#1,A$(X,X),"    ",
160 FOR Y=1 TO 10
170 PRINT#1,A$(X,X)+B$(Y,Y),"    ",
180 NEXT Y
190 PRINT#1,\PRINT#1,
200 NEXT X
210 PRINT#1,\PRINT#1,
220 FOR X=1 TO 26
230 PRINT#1,A$(X,X),"(     )  ",
240 Z=0\REM Z=LINE LENGTH COUNTER
250 FOR Y=1 TO 10
260 PRINT#1,A$(X,X)+B$(Y,Y),"(     )  ",
270 Z=Z+1
280 IF Z<>5 THEN 300
290 PRINT#1,\PRINT#1,\PRINT#1,"           ",
300 NEXT Y
310 PRINT#1,\PRINT#1,
320 NEXT X
330 PRINT#1,\PRINT#1,
340 FOR X=1 TO 26
350 PRINT#1,A$(X,X),"$(     )  ",
360 Z=0
370 FOR Y=1 TO 10
380 PRINT#1,A$(X,X)+B$(Y,Y),"$(     )  ",
390 Z=Z+1
400 IF Z<>5 THEN 420
410 PRINT#1,\PRINT#1,\PRINT#1,"           ",
420 NEXT Y
430 PRINT#1,\PRINT#1,
440 NEXT X
450 END
```

Program A.

```
PROGRAM                              DATE                              PROGRAMMER

A      A0     A1     A2     A3     A4     A5     A6     A7     A8     A9
B      B0     B1     B2     B3     B4     B5     B6     B7     B8     B9
C      C0     C1     C2     C3     C4     C5     C6     C7     C8     C9
D      D0     D1     D2     D3     D4     D5     D6     D7     D8     D9
E      E0     E1     E2     E3     E4     E5     E6     E7     E8     E9
   :
Y      Y0     Y1     Y2     Y3     Y4     Y5     Y6     Y7     Y8     Y9
Z      Z0     Z1     Z2     Z3     Z4     Z5     Z6     Z7     Z8     Z9
```

```
A(   ) A0(   ) A1(   ) A2(   ) A3(   ) A4(   ) A5(   ) A6(   ) A7(   ) A8(   ) A9(   )
B(   ) B0(   ) B1(   ) B2(   ) B3(   ) B4(   ) B5(   ) B6(   ) B7(   ) B8(   ) B9(   )
C(   ) C0(   ) C1(   ) C2(   ) C3(   ) C4(   ) C5(   ) C6(   ) C7(   ) C8(   ) C9(   )
D(   ) D0(   ) D1(   ) D2(   ) D3(   ) D4(   ) D5(   ) D6(   ) D7(   ) D8(   ) D9(   )
E(   ) E0(   ) E1(   ) E2(   ) E3(   ) E4(   ) E5(   ) E6(   ) E7(   ) E8(   ) E9(   )
   :
Y(   ) Y0(   ) Y1(   ) Y2(   ) Y3(   ) Y4(   ) Y5(   ) Y6(   ) Y7(   ) Y8(   ) Y9(   )
Z(   ) Z0(   ) Z1(   ) Z2(   ) Z3(   ) Z4(   ) Z5(   ) Z6(   ) Z7(   ) Z8(   ) Z9(   )
```

```
A$(   ) A0$(   ) A1$(   ) A2$(   ) A3$(   ) A4$(   ) A5$(   ) A6$(   ) A7$(   ) A8$(   ) A9$(   )
B$(   ) B0$(   ) B1$(   ) B2$(   ) B3$(   ) B4$(   ) B5$(   ) B6$(   ) B7$(   ) B8$(   ) B9$(   )
C$(   ) C0$(   ) C1$(   ) C2$(   ) C3$(   ) C4$(   ) C5$(   ) C6$(   ) C7$(   ) C8$(   ) C9$(   )
D$(   ) D0$(   ) D1$(   ) D2$(   ) D3$(   ) D4$(   ) D5$(   ) D6$(   ) D7$(   ) D8$(   ) D9$(   )
E$(   ) E0$(   ) E1$(   ) E2$(   ) E3$(   ) E4$(   ) E5$(   ) E6$(   ) E7$(   ) E8$(   ) E9$(   )
   :
Y$(   ) Y0$(   ) Y1$(   ) Y2$(   ) Y3$(   ) Y4$(   ) Y5$(   ) Y6$(   ) Y7$(   ) Y8$(   ) Y9$(   )
Z$(   ) Z0$(   ) Z1$(   ) Z2$(   ) Z3$(   ) Z4$(   ) Z5$(   ) Z6$(   ) Z7$(   ) Z8$(   ) Z9$(   )
```

Program run.

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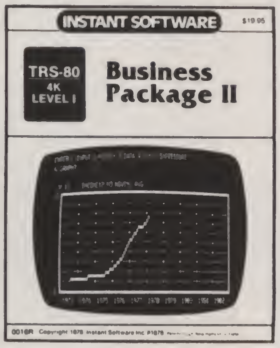

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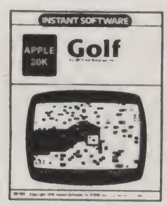

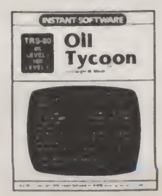

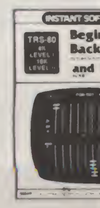

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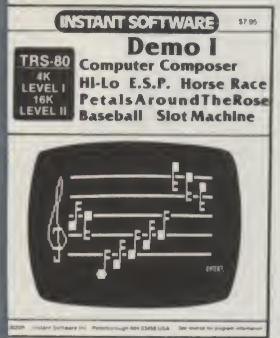

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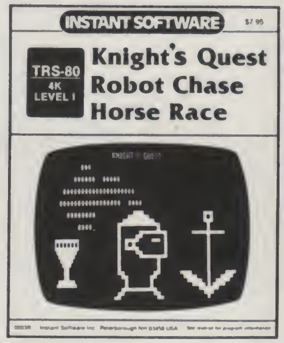

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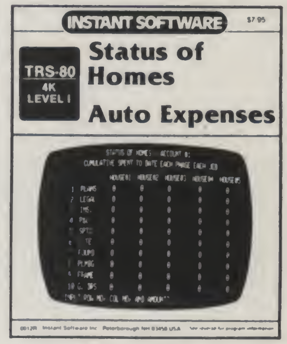

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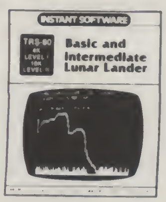

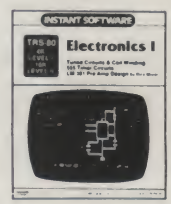

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KILOBAUD KLASSROOM NO. 17

Computer I/O V

It's over—the extended section of Kilobaud Klassroom dealing with input-output, that is. The next time around, we're going to take a look at some processor requirements.

Peter A. Stark
PO Box 209
Mt. Kisco NY 10549

For the past several sessions, we've been looking at the various kinds of input/output (I/O) methods used by computers. We finally got to interrupts and looked at the simple interrupt system used by the 6800 processor.

We are now ready to finish the topic (I promise!) by seeing how the 8080 and Z-80 processors do it and then taking a brief look at the direct memory access (DMA) technique. So here goes.

Introduction

Last time I described what interrupts do and how. We found out that an interrupt system simply provides a way for I/O equipment to temporarily sidetrack the processor from its usual program to a different program called an *interrupt service subroutine*, or ISS. The ISS takes care of whatever the I/O device needs and then returns to the main program.

Since an interrupt can be caused by many different devices, one of the first things the processor must do is to find out where that interrupt came from. We mentioned that the ISS could do that by checking the various device READY lines, but that a faster way was to have several ISS programs—one for each different kind of interrupt. We would then provide a hardware circuit that would determine the cause and force the processor to go to the right ISS routine. This is called *hardware vectoring*.

If this is done right, it also solves a second problem—handling important interrupts first, and even letting important interrupts (higher-level ones) interrupt less important (lower-level) ones. This is called a *priority interrupt system*.

We then found that the 6800 had two types of interrupts (IRQ and NMI), but that the IRQ was the only one used for run-of-the-mill interrupts. Thus there was only one ISS, whose address was pulled by the processor out of a ROM memory transfer vector. This made the entire job simple, if just one interrupt routine was to be used. But if we needed several routines with hardware vectoring and some kind of priority system, external hardware had to be added. Specifically, Motorola's MC6828 Priority Interrupt Controller (PIC) was designed just for that.

Now we see how some other processors tackle the same problem. But the purpose of Kilobaud Klassroom isn't to make you a high-class hardware designer. So I won't go into as much detail on the 8080 and Z-80 processors as I did with the 6800. I'll just describe the general approach that Intel and Zilog took with them; if you want to read up on the specific details, there is an excellent description in a series of books called *An Introduction to Microprocessors* by Adam Osborne. Either volume II, "Some Real Products," of the 1977 edition or volumes II and III of the 1978 edition have the full story in a nice format.

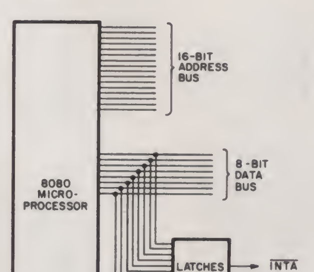

Fig. 1. Interrupt control lines in an 8080 system.

Interrupts in the 8080

Unlike the 6800, the 8080 is designed for many different interrupt levels but requires some external circuitry to operate. In fact, even if you use only one level, you will still need some external circuits.

Fig. 1 shows the three interrupt control signals used with an 8080. Let's look at them one by one.

As with any computer, there must be a way for a program to turn the whole interrupt system on or off; the 8080 does this with a pair of instructions called EI (Enable Interrupts) and DI (Disable Interrupts). The INTE (INTerrupt Enabled) output from the 8080 tells external devices whether the interrupt system is on or off at any particular time. In most computers this signal is not used, since usually an I/O device will request an interrupt

when it needs it, regardless of whether the processor is ready to accept it at that particular instant or not. Most I/O devices couldn't care less whether the system is enabled or not.

The INT signal is the only interrupt input on the 8080. (It is maskable; there is no non-maskable interrupt, as there is on the 6800.) If the interrupt system is on, then when the INT input goes high the 8080 finishes its current instruction and interrupts. At this point it is ready to jump to an interrupt service subroutine, but the external circuitry has to tell the 8080 where to find it.

This is where the $\overline{\text{INTA}}$ (INTerrupt Acknowledge) line comes in. At the instant that the 8080 gets ready to go to the ISS, it sends out on the data bus a bit that must be latched off the bus at a precise time. This is accomplished by a set of latches and the control circuits that go with them and results in the $\overline{\text{INTA}}$ signal going low. This tells the external interrupt circuits that an interrupt is just starting.

As soon as this $\overline{\text{INTA}}$ signal comes out, the interrupt circuitry has to send back to the 8080 a "jump to subroutine" instruction, which will send it to the appropriate ISS.

The most common instruction used is an RST, or ReSTart, instruction, a one-byte instruction that has the following format:

111xxx11

where the letters xxx stand for three bits that specify one of eight different ISS starting points.

Since these addresses are all fairly close together, it usually isn't possible to put an entire ISS in between them. In almost every case, these addresses just make up a "jump table" in memory, that is, a set of jump instructions that simply tell the processor to continue the ISS somewhere else in memory. So in a sense this is like a transfer vector, with an I/O device specifying the exact starting point with a restart instruction.

Fig. 2 shows how this restart instruction could be sent from an I/O device in response to the $\overline{\text{INTA}}$ signal. The heart of the circuit is a set of eight three-state buffers. The restart instruction bits are simply wired to the inputs of the buffers, with +5 volts for 1 and ground for 0.

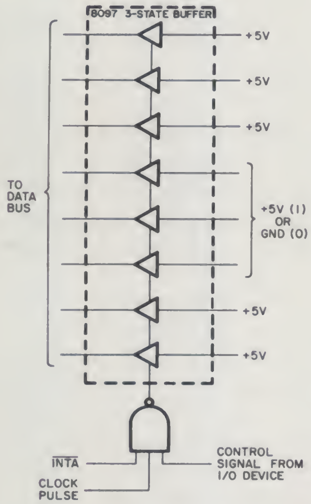

Fig. 2. RST (Restart) instruction supplied by an I/O device.

When the $\overline{\text{INTA}}$ acknowledge is received along with a clock signal and an enable signal from the I/O device, the three-state buffers are enabled and send the RST code to the processor.

A simple circuit such as this can handle the vectoring but can't properly handle the job of assigning priorities to levels. So it is usually used only where there is just one interrupt level. If there is more than one, then one of the interrupt controllers in the 8080 microprocessor family is usually used.

Intel makes two ICs—the 8214 and 8259, called Priority Interrupt Control Units (PICUs) —for this purpose but there are others as well. The PICU not only handles the job of sending the appropriate ISS starting address to the 8080, but also takes care of setting priorities, can prevent lower-level interrupts from interrupting higher-order ones, can let I/O devices know when their interrupt is accepted and can handle assorted other jobs as well.

From this description it looks as though the 8080 interrupt system, since it was originally designed for multiple level interrupts, is somehow better than the 6800's system. But this isn't really true—like the 6800, the 8080 needs a lot of external circuits to do its work. Both can handle multiple levels, but the 6800 has the advantage that it can work alone for single-level interrupts. The 8080 needs external restart logic even for simple interrupt systems.

Interrupts in the Z-80

Since the Z-80 is supposed to be able to run 8080 programs, it has to be able to execute interrupts in the same way as an 8080. This it does, but it does a few other tricks as well.

As Fig. 3 shows, the Z-80 doesn't have an INTE output. No great loss. $\overline{\text{INTA}}$ is present but generated in a different way, and now there is a non-maskable, or $\overline{\text{NMI}}$, input, just like that of the 6800. And it's usually used for the same purpose as the $\overline{\text{NMI}}$ in the 6800—jump to a routine to save everything in case of a power outage. But the Z-80 has three ways of handling interrupts: the three Interrupt modes.

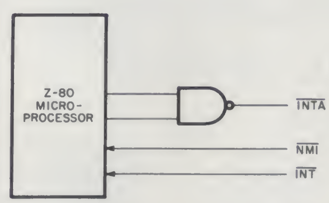

Fig. 3. Interrupt control lines in a Z-80 system.

Mode 0 is just like that of the 8080—external circuitry has to send a "jump to subroutine" instruction to the processor to tell it where the ISS is located.

Mode 1 is similar to the way a 6800 handles an interrupt request. In the case of the Z-80, an interrupt in Mode 1 always makes the processor jump to hexadecimal address 0056. So Mode 1 is for single-level interrupts and doesn't require any external hardware to specify the starting point of an ISS.

Mode 2 is an improvement over Mode 0 since it allows up to 128 interrupt levels. Somewhere in the memory of the system, you place a transfer vector having up to 128 addresses. Then, when an interrupt occurs, the Z-80 sends out the $\overline{\text{INTA}}$ signal, and external hardware has to send in a 7-bit number specifying which of the starting addresses to use.

How Important Are Interrupts?

That's an interesting question we should ask before we get too excited about how well one microprocessor handles them in comparison to another.

In most small home or business computers, interrupts are used infrequently or not at all. The volume of work simply doesn't justify them. Although it is true that many programs might run faster when interrupts were used than without them, the extra time needed to write the programs and make them work would probably be much greater than the computer time saved.

On a small home or business computer, time is cheap. The system is so inexpensive that it doesn't matter if it isn't used to its capacity. Human time is more valuable than machine time. A good interrupt program might take so long to write that the programming effort would far outweigh the savings in computer time.

Let's look at it another way. The main use for interrupts is to allow several things to go on at the same time. This can involve several different I/O devices, but traditionally it has also meant combining processor time (computing) with I/O.

All of this dates back to the days when the central processing units (CPUs) of computer systems cost hundreds of thousands of dollars. They cost much more than the average I/O device they were connected to. So to make the best use of these expensive CPUs, the approach was to connect as much I/O equipment to a CPU as possible and then set up the programming so that the CPU could work on two or more things at the same time.

But that picture has changed. Today you can buy a microcomputer system with 16K or 32K of

memory for less than just one I/O device. It may be better and easier to get several processors than to try to use just one for several jobs at the same time.

Also, today's microcomputers are not as fast as some of the big CPUs of yesterday, and when they are connected to a complex interrupt system with many levels of interrupt, they may simply be outclassed. They may spend too much time housekeeping and not enough time doing useful work. It may be more efficient to break the system up into several smaller ones—each having its own processor.

So we find that an interrupt system is useful; in fact, in some cases (such as a power-fail interrupt in some systems) it is essential. In most cases, however, a simple interrupt system will do the job. Being able to handle 128 levels of interrupt may be just a little too much.

Direct Memory Access

Although an interrupt system may speed up a processor's response to an I/O device's need, once the interrupt occurs the actual transfer of data is still handled by programming. It is still limited by the speed of the processor, and in some cases this is not fast enough. Let's look at the example of a mini-floppy system to see what's involved.

In a small floppy drive, such as a Shugart SA400 or Wangco model 82, each track has a capacity of 3125 bytes, or 25,000 bits. Since the disk turns at 5 revolutions per second, this works out to 125,000 bits per second, or 8 usec per bit.

None of the popular microprocessors is fast enough to get a byte out of memory, unpack it into bits and send them out at that rate, so the conversion from bytes into individual bits and back has to be handled by external hardware. That's the job of the disk controller.

Now the processor, instead of having to send one bit out to the disk drive every 8 usec, must send out a complete byte every 64 usec. Considering the overhead the processor has to go through, such as counting the bytes, checking for the maximum count, getting the byte out of memory, incrementing the pointer so each byte will come out of the next memory location and so on, this is an acceptable speed, and most processors would have no trouble keeping up. But the only way that the microprocessor can handle this speed is to first organize the data into a neat table in memory, with all of the bytes to be sent stored in consecutive memory locations so that a minimum amount of work is necessary once the data starts to move.

Let's say, however, we want to use one of the newer, so-called double-density drives. The disk still turns at the same speed, but there are twice as many bits on a track. Now the bits come 4 usec apart, and a whole byte takes 32 usec, instead of 64. At this point we find that the typical microprocessor has a hard time keeping up, and some can't do it at all.

Most microprocessors are used with memories that can read out a byte in one usec or less, so the memory isn't the bottleneck. The problem is that the processor can't just read out a number and send it out. It has to go through a lot of housekeeping in addition to actually transferring the data. It's this extra work that takes time.

This is where direct memory access, or DMA, comes into the picture. With DMA, the disk controller can get the data out of the computer's memory directly without going through the processor first. To do this, the computer now needs a special circuit to handle the job; this circuit is called the DMAC, or DMA controller. DMA is performed in one of three ways:

Burst Mode. In burst mode, the processor is completely stopped, the DMA controller takes over the address and data buses (and control lines such as R/W) and a large number of bytes is moved into or out of memory in a burst.

Single-Cycle Mode. In this mode, the processor is also stopped, and one byte is transferred by the DMA controller

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over the data bus. Because only one byte is involved, the processor is stopped for a shorter time than in burst mode, and so the stopping method may be different. For instance, the processor may just be slowed down by lengthening a clock pulse to give the DMA controller time to sneak in and do a data transfer.

Cycle-Stealing Mode. In this mode, the processor is not stopped at all. Instead, it's allowed to go on with its program in a normal way. But most processors do not use the data and address buses all the time; during a typical instruction there may be several clock cycles when the processor fetches an instruction or data out of memory, followed by a few more cycles when the processor does some internal operation not involving the buses. The DMA controller uses this extra time to perform a data transfer on the bus without the processor even knowing about it.

All of these DMA operations depend on the DMA controller's being able to use the data and address buses and control lines with the processor disconnected from them. This means that there will now be three-state buffers all over the place, allowing each of these buses to be fed by several sources.

Fig. 4 shows a simplified diagram of how an 8257 DMA controller would be connected to an 8080 system; this particular diagram applies specifically to 8080 systems, but the DMA operation is quite similar on other systems as well.

Fig. 4 is drawn with the 8080 on the left end of the address and data buses and the DMA controller on the right end. I configured it this way purposely to show that they share the control over them almost equally. Most of the time the DMA controller is completely disconnected from the buses, and the 8080 processor is running the show; but during DMA operations the 8080 disconnects itself, and the DMA takes over everything. (Although the 8257 DMA Controller is shown with only one I/O device, it can actually control up to four. That would just complicate an already confusing situation, so let's stick with just one. There are a few other aspects that Fig. 4 doesn't show; they are important in actual operation but would just confuse us even more at this point.)

To see how all this fits together, let's go back to our example of the floppy disk system (i.e., the I/O device in Fig. 4). Let's start by supposing that the program calls for a block of data to be written from memory to disk. The entire sequence of operations to do this goes something like this:

1. Before doing anything, the processor (under program control) assembles the data in consecutive memory locations, counts the total number of bytes, calculates a check number, which will be stored on the disk along with the data and used to check its accuracy when it is read back, and determines exactly where the data will be stored on the disk.

2. Using standard I/O operations (not DMA), the processor instructs the disk to turn on the motor and position the read/write head over the track where the data will be stored. This might involve the interrupt system, with the processor doing something else while the above is happening, and the disk controller generating an interrupt when the disk drive is ready for writing the data.

3. Next, the processor sets up the DMA controller to prepare for the data transfer. (The DMA controller has its own address decoder and select signal and can be addressed by the processor like any other I/O device.) To do this, the processor sends to the controller three pieces of information: the address in memory where the data to be sent out to the disk is stored, the number of bytes to be sent and the type of transfer required (read or write.) This information is stored in the controller's internal registers.

4. When the disk's read/write head is properly positioned, the processor tells it to go ahead and request a DMA transfer as soon as it is ready. The processor now goes on to do something else while the I/O is being

✓ *Reader Service—see page 179*

carried out.

5. When the I/O device is ready, it sends a DMA request to the DMA controller.

6. The DMA controller sends an HRQ (Hold ReQuest) signal to the processor.

7. The processor finishes up the current operation and then goes into a "Hold" state. This is a dormant state when it stops all operations and turns off the three-state buffers that drive the data and address buses. At this point these buses are completely released by the processor. When this is completed, the processor sends an HLDA (HoLD Acknowledge) signal back to the DMA controller.

8. Next, the controller sends out the AEN signal to the three-state buffers that normally feed the MEMR (MEMory Read), MEMW (MEMory Write), I/OR (I/O Read) and I/OW (I/O Write) lines from the processor. This turns off these buffers and allows these control lines to float.

9. The next step is to turn on all the three-state buffers that connect the data bus, address bus and control lines to the DMA controller. Now the controller has full control of the entire system, since the processor has been forced off all the buses.

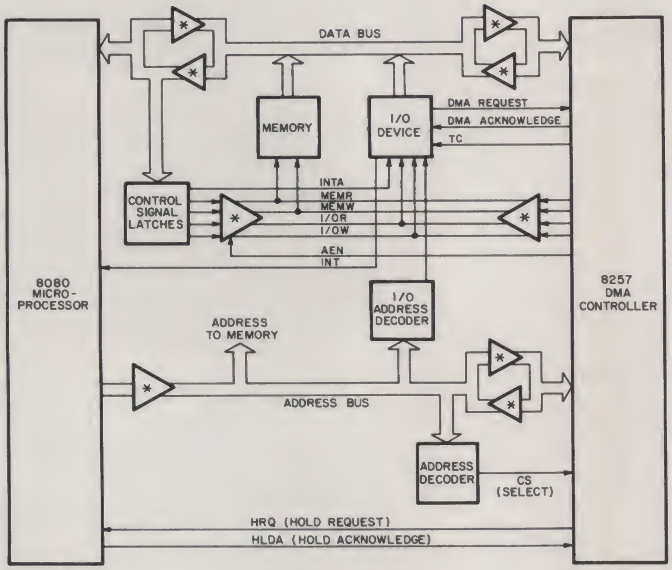


*Fig. 4. Simplified diagram of an 8257 DMA Controller connection to an 8080 processor. (Note: * means three-state buffer.)*

10. Recall that at the beginning of this DMA sequence, the processor sent to the DMA controller the address of the data to be sent to the disk, the count indicating the number of bytes to be transferred and a code telling it whether this is going to be an input or output. The DMA controller now sends the first address out to the address bus. (Although not shown in Fig. 4, part of the address is sent out on the data bus, and some extra circuitry has to be added to move it from there back to the address bus.)

11. After a short delay, the controller turns on the MEMR (Memory Read) signal, which reads the first byte out of the memory location whose address is on the address bus.

12. Right after that, the DMA controller turns on the I/OW signal, which sends that byte to the disk. (Since this is an output transfer, MEMR and I/OW are used; if this was an input, the controller would pulse the I/OR and MEMW signals.) This combination actually transfers one byte straight out of memory to the I/O device, completely bypassing the processor itself.

13. When the data transfer is finished, the DMA controller turns off the MEMR and I/OW signals.

14. What happens next depends on how many bytes are being transferred at a time. Assuming a burst of data, the DMA controller will now add 1 to the address and subtract 1 from the count. If the count hasn't reached 0, meaning that some bytes haven't been transferred to the disk yet, the controller will repeat the transfer again (by sending out the next address, etc.).

15. When all of the data has been transferred (as shown by the count's going to 0), the controller sends a TC signal to the disk controller to tell it that the operation is finished. As a result, the disk controller turns off the DMA Request signal and the DMA controller turns off the Hold Request and AEN signals. The three-state buffers on the DMA controller side of the buses turn off; the three-state buffers on the 8080 go back on; and the 8080 comes back to life and continues as if nothing had happened.

There is obviously a small delay before the 8080 responds to the DMA request, and all of the three-state buffers switch themselves around. If the DMA does only 1-byte transfers at a time (stuffed between or into regular 8080 instructions), this delay will limit how many bytes can be transferred per second. But if data is transferred in a burst mode, then the rate of data transfer will be limited only by how fast the memory and I/O device can handle it. This means that the burst mode of DMA access is the fastest possible I/O method there is.

In general, DMA will be used only when the I/O speed demands it. You will seldom see it used with mini-floppy disk interfaces, since there is usually enough time to transfer data between the disk controller and the processor under program control. But you will often see it with full-size floppy disks or hard disks, which operate at a faster speed. (There is actually another trick that some manufacturers use to achieve the higher speed without DMA: place a small amount of RAM directly on the disk controller board. The processor can communicate with this RAM at its own rate, but the controller has immediate access to it at high speed. Since this RAM is separate from the main system RAM, the disk controller can use it without interfering in any way with the normal operation of the system.)

DMA is also often used when two processors communicate together and share the same memory, although it usually isn't called DMA then.

Since the processor isn't involved with the actual DMA transfer, it doesn't have to go to an ISS during it. The program that is running at the beginning of the DMA simply is temporarily stopped and then resumes as if nothing had happened. The only time this may affect the program is if a timing loop is being done to cause a fixed delay. If a DMA occurs during it, the delay will be longer than expected. This will sometimes cause problems.

Interesting things sometimes happen if an interrupt occurs during the DMA transfer. Since the processor can't do anything then (some people say it is "asleep" during a DMA transfer), it can't acknowledge an interrupt. This may result in loss of data in some other device.

Also keep in mind that, although it's theoretically possible to do two sets of DMA transfers at the same time (by either interleaving the individual bytes between each other or by splitting the memory into two parts so two memory reads or writes can be performed at the same time), this really complicates things and so is never done in small systems. A system with two disks wouldn't operate both at the same time.

Conclusion

Any discussion of DMA becomes boring after a while, since it's a fairly complicated subject with many possible pitfalls. Few, if any, small manufacturers use DMA, since it is so hard to use it right.

Rather than go into it too deeply here, let's quit for this time around. The next Kilobaud Klassroom will deal with some of the processor requirements, such as clock control signals. Cheer up—we're very close to the end. ■

The Electric Pencil

A rock group in the 60s? Actually, it's a word-processing system from Michael Shrayer.

Rod Hallen
Road Runner Ranch
PO Box 73
Tombstone AZ 85638

Like a great many computer hobbyists, I am always looking for new tasks for my machine to do. My recent purchase of a Teletype Model 43 KSR at last gave me hard-copy capability, which is great for memory dumps and BASIC program listings. However, formatting letters and manuscripts was difficult since my new printer did not exceed the 64-character-per-line limit of my video terminal. Every time that the video returned to a new line, the KSR did also.

I needed a text editor, and I found a good one. The Electric Pencil by Michael Shrayer is a character-oriented word-processing system. It does not use line numbers as in BASIC. Instead, text is entered as a continuous string of characters and then is manipulated as such.

While you are entering text, it is not necessary to hyphenate or use the return key. The Electric Pencil will take care of that automatically. If you reach the end of the screen line in the middle of a word, a CR-LF is performed, and the broken word is moved to the beginning of the next line and put back together. A line feed is entered when you want to indicate the end of a paragraph.

Characters, words, sentences and even paragraphs may be inserted or deleted at any time and at any location, and the text will open up or close up as required. Since all of this takes place on the video screen, you always see the result of any changes.

Although I will spell out the commands in this article, single-letter control characters are actually used to enter system commands. See Table 1 for a list of functions available. Most are self-explanatory, but a few may need clarification. SCROLL UP and SCROLL DOWN allow you to review text that has already been entered. The space bar stops and steps the scroll if you want to make changes, and the return key starts the scroll again.

STRING SEARCH is a flexible editing tool. After typing the STRING SEARCH command, you enter the string you want to find, and when it is found, that portion of the text will be brought to the screen. CONTINUE SEARCH will cause the next occurrence of that string to appear. This can go on as many times as necessary.

This makes name and address lists feasible. The list can be coded, and certain codes called out and printed. Another feature of STRING SEARCH is search and replace. If an old and a new string are specified, the old will be replaced by the new each time that it is found.

The REPEAT command has many uses. It can be used to repeat characters or lines, but I have found it most useful when I want multiple copies. "REPEAT" 3 "PRINT" will print three copies. EXIT gives processor control back to your resident monitor program.

Calling the SUB-SYSTEM COMMAND TABLE permits you to format the final printed copy. This table is brought to the screen, and you make your decisions. It has some interesting features (see Table 2). Capital letters and not control characters are used for these commands.

TAPE READER and TAPE WRITER allow you to save letters, manuscripts, etc., on tape for future use. The SOL version of the Electric Pencil allows you to name files dumped to tape. They can then be retrieved by name like any other SOL taped program.

WORD NUMBER will be especially useful to authors who get paid by the word. It will count and display the total number of words contained in the text. RECORD NUMBER will do the same for paragraphs.

CLER AA CUR, CLER AB CUR and CLER SYSTEM are used to clear all or part of a text file.

The rest of the sub-system commands do the actual print formatting. You determine how you want the finished copy to look and use these commands accordingly. PAGE LENGTH sets the number of lines printed on a page, and then a form feed is automatically performed. A form feed can also be entered at any location in the text to take care of special requirements. PAGE SPACING sets the number of lines that the form is fed on a form feed. PRNT LENGTH is used when you only want to print a portion of a complete text.

LEFT MARGIN is used to start a line, and LINE LENGTH sets

Cursor Left	Cursor Right
Cursor Up	Cursor Down
Cursor Home	Cursor to Beginning of File
Cursor to End of File	Scroll Up
Scroll Down	Delete Character
Delete Line	Insert Character
Insert Line	Erase to End of Line
Delete Block	Insert Block
String Search	Continue Search
Repeat	Print
Exit	Sub-System Command Table
Form Feed	Line Feed
Return	Tab

Table 1. The Electric Pencil System commands. Each of these is assigned a control character that implements the command.

Tape Reader	Tape Writer
Word Number	Rcrd Number
Cler AA Cur	Cler AB Cur
Cler System	Rght Justfy
Line Spacng	Page Spacng
Page Length	Page Number
Prnt Length	Line Length
Left Margin	

Table 2. The Sub-System Command Table. Each command is assigned an uppercase letter which implements it. This is where you format the printed copy.

the character length of the line. I've found on my 43 KSR that a left margin of ten and a length of 80 will center a line of characters horizontally on an eight and a half inch wide sheet of paper. This is determined by the number of characters per inch for a particular printer.

Right justification, RGHT JUSTFY, is a useful and attractive feature. The Electric Pencil justifies the right margin by adding spaces in a line as required.

I accidentally threw it a curve by entering two consecutive 26-character strings and then asking for a 32-character line length. It apparently didn't know where to put the spaces (it never places them in the middle of a word) so it didn't do anything, and I had to reset my processor. By breaking down the long strings with spaces, everything came out OK.

Another author-oriented feature is page titling and numbering. When a title has been indicated, the title and a page number will be printed at the top of each page.

I have also found this program helpful with my letter writing. The entire letter is entered, reviewed and corrected, and printed out. Previously, I often retyped letters because I found that, when finished, they didn't say what I wanted.

The 25-page manual that comes with the Electric Pencil clearly explains all of its functions. A three-page glossary defines all of the terms that are used in the manual. Above all, it admonishes, "*The best way to learn to operate the system is to use it.*" Well said! The manual also contains patching information so that it can be reconfigured if your machine is not exactly the same as the one it was written for.

The Electric Pencil is available in many different versions on tape and disk (see Table 3). Contact Michael Shrayer Software, 1235 Vista Superba Dr., Glendale CA 91205, (213) 956-1593, for more information. I bought the SOL version on CUTS cassette tape, and it ran without any software or hardware changes (cost for manual and tape: $100).

I used to do all of my writing in pencil before attempting a hand-typed hard-copy. Now I save time by going straight to the screen with my text. Instead of erasing, crossing out or adding inserts, I do all of my editing on the screen, and when I am satisfied I dump a copy on my printer. After seeing that copy, I may still make some more changes, but it is so much simpler and quicker now.

Of all the programs that I have running on my SOL, I find myself using the Electric Pencil most often. Those computer hobbyists and business people who have both video and hard-copy capability and who do a lot of typing should try it. ■

Electric Pencil Versions

Printer	Video	Storage
TTY or Selectric	SOL	Cuter
" "	VDM-1	Tarbell
" "	VTI	Tarbell
" "	SOL	North Star
" "	VDM-1	North Star
" "	VTI	North Star
Diablo Hy-Type II	SOL	Cuter
" "	VDM-1	Tarbell
" "	VTI	Tarbell
" "	SOL	North Star
" "	VDM-1	North Star
" "	VTI	North Star

Table 3. Various combinations of printer, video interface and mass storage for which the Electric Pencil is written.

Ken Knecht
KENCOM Co.
1890 W. Colorado St., #7
Yuma AZ 85364

How to Talk to Your 8080

Use machine language or an assembler. This 3-part article will show how to do both.

The most basic way of programming a computer is to use machine language. One step above that is using an assembler. In this article I'll help you learn how to do both.

The chip (microprocessor) I'm describing is the 8080. The Z-80 has this same instruction set as part of its instruction set. Other microprocessors are not too different once you study their operation.

First of all, machine language is the code that directly programs the computer. All other programming techniques use commands that break down, invisibly to the user, to machine-language instructions.

Eight-bit binary numbers are input to the CPU. If the front-panel switches are used, you program directly in binary. However, if you use a monitor program, you can input instructions via a terminal in octal or hex, depending on which the monitor uses. If you use the front-panel switches, the computer outputs its answers to you by lighting the data lights —eight of them—in binary. If you use the monitor, the computer responses are printed on the terminal, again in octal or hex, depending on the monitor.

To go into a little more detail, we'll use the Altair 8800 as our computer. Other computers that have front-panel switches use a similar system.

The Front Panel

As you can see in the photo, there are 16 switches, each with a light above it. In addition, there are eight more lights with no switches. The 16 lights are used for the address; the other eight are for data.

There are over 65,000 different combinations of the 16 address switch positions; each combination accesses one byte of memory. Of course, you probably don't have that much memory. If you have less, your memory generally starts at address 0 and continues up to the limit of memory.

Normally your memory boards should be addressed so each memory board is adjacent to the next, with no gaps in memory. For example, let's say you have one 8K RAM (programmable memory) board and three 4K RAM boards. You could address the 8K board for the first 8K of memory, 0 to 8K memory addresses, then a 4K addressed for the 8K to 12K addresses, the next 4K for the 12K to 16K addresses and the last 4K board for the 16K to 20K.

You now have a solid block of memory for addresses 0 to 20K (see Fig. 1). You cannot address any memory location higher than 20K, as there is no memory covering those addresses.

Understand now, there is no reason why you couldn't scatter these memory blocks all through the 64K of addressable memory, but it would make programming much more difficult because you would have to program around the unused addresses to get from one block to another. Also, if you used a high-level language, the memory would have to be all in one big block, usually starting from address 0.

The right eight address switches are used to input data, with eight data lights confirming the data entered. The 16 address lights are used only for addresses, to tell you which address the computer is accessing at the moment. The data lights show what data is in that address.

There are also several other switches used in programming. The ones we will be using are labeled: (1) Stop and Run, (2) Reset, (3) Examine and Examine Next and (4) Deposit and Deposit Next.

Accessing and Depositing Data

When you power up the computer, you have to reset it to begin using it. To do this, switch the Stop/Run switch to the Stop position and, while holding it in Stop, switch the Reset switch to Reset. This will stop the computer and cause it to address the 0 address. This can be seen by all the address lights being off, indicating 0. There is liable to be most anything showing on the data lights.

To look at the contents of any memory address, switch the address switches to that address and move the Examine switch to Examine. An address switch up turns the switch on; down turns it off. Now the address light above each address switch in the up position will go on, showing that the computer is now accessing that address. The data lights will show the data stored at that address.

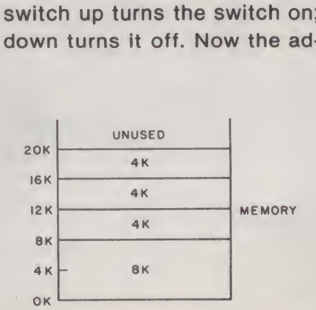


Fig. 1.

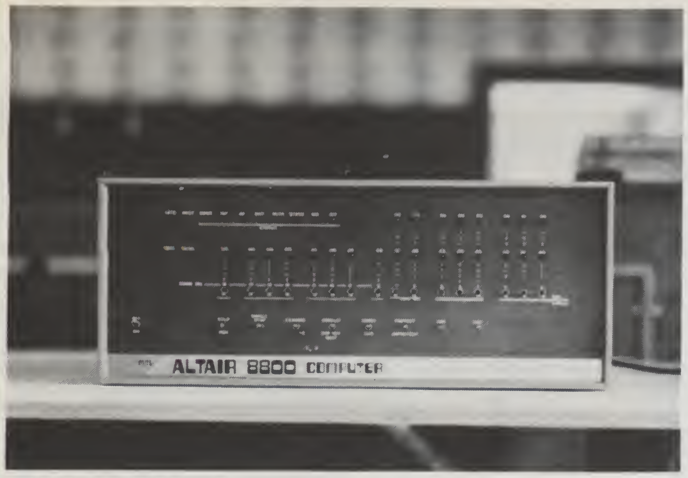
To change the data, switch the eight right address switches to the 8-bit binary number you wish to put in that address and switch the Deposit switch to Deposit. The eight data lights should now light in the same pattern as the eight switches.

This data is now stored at that memory address. To examine the next sequential memory address, switch to Examine Next. The binary number on the address lights will increase by one showing the next address. The data lights, as before, will show the data at that address.

The Deposit Next works about the same way. It moves to the next address and deposits whatever data you have set on the right eight address switches in that next address.

To review, the address lights always show the current address. The examine function uses the 16 switches to select the address you want. The data lights always show the data stored in that indicated memory address. The Deposit switch uses the right eight address switches to determine the data you wish to deposit at the address shown on the address lights.

If you Examine an address where you have no memory, the address lights will still indicate the address you selected, but all eight data lights will go on. Any attempt to Deposit data at the address will have no effect



The Altair 8800.

on the data lights.

To run a program, enter it into the desired addresses with Deposit and Deposit Next. Then examine all the addresses to be sure you entered the program properly. Then examine the address of the first instruction in the program and hit the Run switch. You're on your way!

Hex and Octal Numbering Systems

To convert from binary to hex or octal numbers is simple. To convert from binary to decimal is quite difficult, so we will do the programming in octal with hex numbers added for those who prefer that format.

In decimal we count 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, etc. In octal we count 1, 2, 3, 4, 5, 6, 7, 10, 11, etc. Thus the largest digit is a 7. You cannot use an 8 or 9 in octal. We'll soon see why. In hex we count 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, F.

To input an 8-bit octal number, the size we will always use, we convert from the switches to each digit as follows:

0 octal is 000 in binary
1 octal is 001 in binary
2 octal is 010 in binary
3 octal is 011 in binary
4 octal is 100 in binary
5 octal is 101 in binary
6 octal is 110 in binary
7 octal is 111 in binary

Memorize these eight digits; you will be using them all the time in programming.

Since we can only use three switches for each octal digit we cannot go higher than 7, as we have used up all the possible switch combinations. So in eight bits the highest number we can enter is 377 octal, or 11 111 111 binary. This will be ample for our programming.

In hex we use four bits for each digit, with two digits for an 8-bit number. One to 7 is the same as octal, with an additional leading binary 0.

8 hex = 1000 binary
9 hex = 1001 binary
A hex = 1010 binary
B hex = 1011 binary
C hex = 1100 binary
D hex = 1101 binary
E hex = 1110 binary
F hex = 1111 binary

When using the address switches we have 16 switches, so the highest binary number we can enter is 1 111 111 111 111 111, or 177777 octal. This is over 65,000 in decimal. It is FFFF in hex.

However, if we have to enter an address as data, we are limited to eight bits—377 octal or FF hex. So we divide our 16-bit binary address into two 8-bit octal numbers when entering it as data.

So the octal address 124671 would be 1 010 100 110 111 001 in binary. To divide (break) it into two 8-bit octal numbers, we have to arrange the binary number as 10 101 001 and 10 111 001. Note that this is the same order as our original 16-bit binary number, but we have rearranged most of the groups.

So 124671 in address form, or split octal, would be 251 and 271. To enter the 16-bit address as two 8-bit octal numbers, we would enter 271 as the low half of the split octal address and 251 as the high half. The computer puts these back together as a 16-bit binary number and gets the octal number we started with, that is, 124671.

Addresses are always changed to split octal when entered as 8-bit data. And since we will be using addresses frequently, you must know how to convert to split octal. Let's do one more to be sure you understand how this works.

Let's say our address is 123456 octal. To change it to split octal, break it down to binary, then split the binary number into two 8-bit halves. This will give us 1 010 011 100 101 110, 16 bits in all. We divide this into two 8-bit halves as 10 100 111 and 00 101 110, or 247 and 056.

So 123456 octal is 247 and 056 in split octal. Get it? I hope so! Split octal is written as 247/056.

In hex we can translate directly; there is no equivalent to split octal. Therefore, a hex address of A97D would split to A9 and 7D. Remember also: An address (or data) switch in the up position is a 1; in the down or off position it is a 0.

Now that we know how to get numbers into the computer, let's talk about which number we use to get the computer to do our bidding.

Mnemonics and Monitors

When we give the 8080 instruction codes in octal and hex, we will also give a mnemonic, or letter group. These mnemonics are used in assembly language, and we will be using them as helpful memory joggers in the machine-language program examples.

You don't have to memorize each mnemonic and its octal or hex number equivalent, as you can always look them up. But they are not hard to remember, so you will gradually memorize them as you use them.

Earlier I mentioned the monitor. This is a program that lets you input and output data to and from the computer using a terminal. Essentially, it lets you do everything you can do with the front-panel switches, but with a terminal, instead.

The monitor might also do other more complex things such as saving programs on tape or loading them from tape into the computer, etc. But in this article we are interested only in emulating the front-panel switches discussed. Most monitors will do at least this much.

The monitor commands are given in the instructions you received with it. Insofar as inputting instructions and data, we will assume the monitor uses octal or hex. Then you don't have to worry about the binary information I gave you about switches, etc. You need only type in the data in octal or hex. All instructions, addresses, data, etc., are given in octal and hex in this article.

As I mentioned earlier, the monitor program instructions should tell you how to examine (look at) the contents of any memory address or deposit (store) data in any memory address and how to set the starting address and run any program.

One other thing I should mention—and I hope I won't confuse you—is that the monitor is a program and must be somewhere in your computer memory to use it. The monitor documentation should tell you where it is located in memory. The point is: Don't load your programs in memory addresses

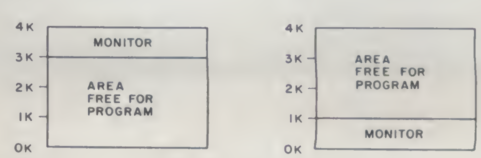


Fig. 2.

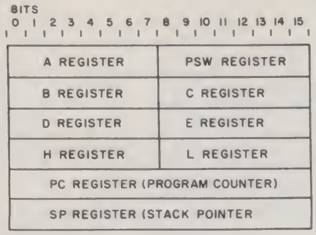


Fig. 3.

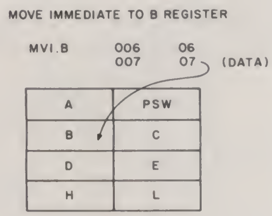


Fig. 4.

used by the monitor program.

The programs I will use for examples all start at the lowest memory address. If your monitor starts there, you will have to load all your programs at a higher address (see Fig. 2).

The simplest way to do this is to add 1 to the high part of the highest address used by the monitor. Then use this high address as the high address in all the programs you load. Use the same low-address halves I use in the program (see Fig. 2). When you have 3-byte instructions such as LXI, JMP, CALL, etc., then substitute this high-address half for the one given in the program.

For example, let's say we have an instruction such as:

Mnemonic	Octal Code	Hex Code
CALL	315	CD
	214	8C
	000	00

in a program. If your high last monitor address was 003, then add 1 making it 004. Then the CALL would be:

CALL	315	CD
	214	8C
	004	04

The first address I give all the programs is 0. If you used the above monitor, your first address would be 010/000 (4000 split octal), 0400 hex, instead of 0. The idea is to store all the programs above the monitor so you don't write instructions over the monitor and change its instruction codes.

If the high half of the first monitor address is above 000, then all the programs I will use will have no effect on the monitor and can be run as I have written them.

Registers

The 8080 has 12 registers, which we will be using to write our programs. They are the A register, or accumulator; the PSW, or program status word register; the B, C, D, E, H and L registers; the two SP (stack point) registers (always used as one 16-bit register); and the two PC, or program counter, registers (always used as one 16-bit register).

The A and PSW registers are always used as 8-bit registers; the B and C registers can be used as individual 8-bit registers or one 16-bit register; the D and E can be used as the B and C; and the H and L registers can usually be used together as one 16-bit register but sometimes as two individual 8-bit registers (see Fig. 3).

As you may have guessed, 16-bit register pairs are used to hold addresses, and 8-bit registers are used for data (see Fig. 3). We can only store eight bits of data, remember?

These registers can just be considered additional memory locations, but these are part of the 8080, and, instead of using a 16-bit address, we can refer to them by their letter names: A, B, C, etc. We will use these for address and data storage as often as possible in programming. As you will see, they are much easier to use than memory locations.

Moving Data

First we'll look at how we get information into and out of the computer, or I/O. In all instruction lists we will put the mnemonic first, then the octal instruction number, then the hex number:

IN	333	D3
OUT	323	D3

The IN or OUT is followed by a port number, that used by your I/O hardware board. We also have to be sure the computer is ready to receive an input or has an output ready.

To do this we have to check a status flag generated by the I/O board. This requires checking one bit to see if it is high or low. After we learn more instructions, we will see how this is done.

First we will discuss the operation codes to store and retrieve data. To put data into a register, we use the following instructions:

MVI,B	006	06
MVI,C	016	0E
MVI,D	026	16
MVI,E	036	1E
MVI,H	046	26
MVI,L	056	2E
MVI,A	076	3E

In the mnemonic, the MVI means we are using the data following the MVI instruction to the register. The data is input in a following 8-bit code. For example, to move the data 020 to register B, we would first store the MVI,B command, or 006, then in the next instruction or eight bits (byte) we would store the data, or 020.

Thus in address 0 we'd deposit 006 to tell the computer what to do, then 020 to tell the computer what data to move into B. This is a 2-byte instruction (see Fig. 4). Note again that we can only store an octal number from 0 to 377 in an 8-bit register.

These are called immediate instructions, since they move that data immediately following the instruction, as opposed to indirect instructions, which move data stored in a register or memory location. Indirect instructions, therefore, are not followed by a data byte; immediate instructions are (Fig. 4).

This covers all the 8-bit registers. You might have noted that there is one octal code missing in this sequence (that is, 066 between MVI,L and MVI,A). The mnemonic for 066 is MVI,M. This is 36 in hex. But there's no M register!

Well, M stands for memory. So if we write 066 followed by 020 we are saying move 020 to memory. But where in memory? This instruction assumes that the address in memory where we want to store the data is in the H and L register pair (see Fig. 5). So we see why H and L are usually used as a single 16-bit register.

We could store our memory address as follows: The high half of the split octal address in H (high) and the lower half in L (low). So if we wished to move the 020 in the MVI,M (066) instruction to 243/017 split octal address (121517 in octal), we'd use the program in Program 1.

So we must have the desired address in HL whenever we use an instruction that uses M in the mnemonic for a register (see Fig. 5).

There is an easier way to put an address in the following register pairs (BC, DE, HL or SP). We saw that it took four bytes (8-bit instructions to put the address in H and L using MVI. We can use LXI followed by the first of the register pair to load 16 bits directly into that pair.

LXI,B	001	01
LXI,D	021	11
LXI,H	041	21
LXI,SP	061	31

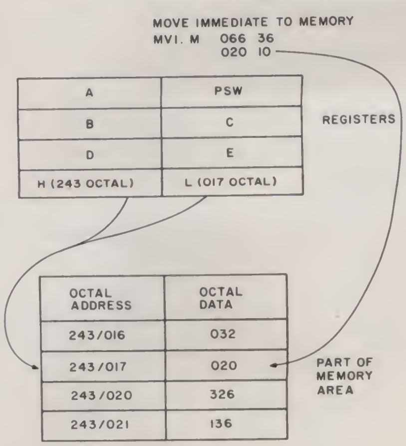


Fig. 5.

The LXI code is followed by two bytes, the split octal or hex address. So:

MVI,H	046	26
	243	A3
MVI,L	056	2E
	17	0F

could be replaced by

LXI,H	041	21
	017	0F
	243	A3

This saves us one byte of code to do the same thing. However, note that we put the low half of the address (017) first, followed by the high half (243, using octal as the example). That is, backwards.

All addresses are handled this way when they are used in a 3-byte instruction. That is, the LXI instruction uses three bytes, the first the LXI instruction, followed by the 2-byte split octal or hex address. So when using any 3-byte instruction (there are quite a few more), the address order (or data order) is reversed.

We'll try to make this very clear with another example, since this concept is confusing but important in programming the 8080. We want to load the split octal address 000/123 (0053 hex) in HL. We use LXI,H (041) as the first instruction, followed by the byte we wish to load in L (123), followed by the byte we want to load in H (0) (see Program 2).

```
Octal   Hex      Mnemonic  Octal  Hex    Comments
Address Address            code   code
000     0000     MVI,H     046    26
001     0001               243    A3    high half of address
002     0002     MVI,L     056    2E
003     0003               017    0F    low half of address

This would put the desired address in HL before we used them.

004     0004     MVI,M     066    36
005     0005               020    10    data
```

Program 1.

Loading any of the register pairs with the LXI (or any 3-byte instruction) works this way (see Program 3).

So anytime we load an address or data into a register pair, we write the data in the reverse order from the register order. We will see many more examples of this as we look at other instructions.

Now we have found out how to put data in most of the registers. We haven't discussed loading the PSW register and the PC register pair. Note that we can only load the SP register pair with the LXI,SP (061 octal,

DATA TRANSFER GROUP		
100	40	MOV B,B
101	41	MOV B,C
102	42	MOV B,D
103	43	MOV B,E
104	44	MOV B,H
105	45	MOV B,L
106	46	MOV B,M
107	47	MOV B,A
110	48	MOV C,B
111	49	MOV C,C
112	4A	MOV C,D
113	4B	MOV C,E
114	4C	MOV C,H
115	4D	MOV C,L
116	4E	MOV C,M
117	4F	MOV C,A
120	50	MOV D,B
121	51	MOV D,C
122	52	MOV D,D
123	53	MOV D,E
124	54	MOV D,H
125	55	MOV D,L
126	56	MOV D,M
127	57	MOV D,A
130	58	MOV E,B
131	59	MOV E,C
132	5A	MOV E,D
133	5B	MOV E,E
134	5C	MOV E,H
135	5D	MOV E,L
136	5E	MOV E,M
137	5F	MOV E,A
140	60	MOV H,B
141	61	MOV H,C
142	62	MOV H,D
143	63	MOV H,E
144	64	MOV H,H
145	65	MOV H,L
146	66	MOV H,M
147	67	MOV H,A
150	68	MOV L,B
151	69	MOV L,C
152	6A	MOV L,D
153	6B	MOV L,E
154	6C	MOV L,H
155	6D	MOV L,L
156	6E	MOV L,M
157	6F	MOV L,A
160	70	MOV M,B
161	71	MOV M,C
162	72	MOV M,D
163	73	MOV M,E
164	74	MOV M,H
165	75	MOV M,L
166	76	HLT
167	77	MOV M,A
170	78	MOV A,B
171	79	MOV A,C
172	7A	MOV A,D
173	7B	MOV A,E
174	7C	MOV A,H
175	7D	MOV A,L
176	7E	MOV A,M
177	7F	MOV A,A
006	06	MVI,B
016	0E	MVI,C
026	16	MVI,D
036	1E	MVI,E
046	26	MVI,H
056	2E	MVI,L
066	36	MVI,M
076	3E	MVI,A
001	01	LXI,B
021	11	LXI,D
041	21	LXI,H
061	31	LXI,SP
002	02	STAX B
012	0A	LDAX B
022	12	STAX D
032	1A	LDAX D
042	22	SHLD
052	2A	LHLD
062	32	STA
072	3A	LDA
353	EB	XCHG
371	F9	SPHL
ARITHMETIC GROUP		
200	80	ADD,B
201	81	ADD,C
202	82	ADD,D
203	83	ADD,E
204	84	ADD,H
205	85	ADD,L
206	86	ADD,M
207	87	ADD,A
210	88	ADC,B
211	89	ADC,C
212	8A	ADC,D
213	8B	ADC,E
214	8C	ADC,H
215	8D	ADC,L
216	8E	ADC,M
217	8F	ADC,A
220	90	SUB,B
221	91	SUB,C
222	92	SUB,D
223	93	SUB,E
224	94	SUB,H
225	95	SUB,L
226	96	SUB,M
227	97	SUB,A
230	98	SBB,B
231	99	SBB,C
232	9A	SBB,D
233	9B	SBB,E
234	9C	SBB,H
235	9D	SBB,L
236	9E	SBB,M
237	9F	SBB,A
004	04	INR,B
014	0C	INR,C
024	14	INR,D
034	1C	INR,E
044	24	INR,H
054	2C	INR,L
064	34	JNR,M
074	3C	INR,A
005	05	DCR,B
015	0D	DCR,C
025	15	DCR,D
035	1D	DCR,E
045	25	DCR,H
055	2D	DCR,L
065	35	DCR,M
075	3D	DCR,A
003	03	INX,B
023	13	INX,D
043	23	INX,H
063	33	INX, SP
013	0B	DCX,B
033	1B	DCX,D
053	2B	DCX,H
073	3B	DCX,SP
011	09	DAD,B
031	19	DAD,D
051	29	DAD,H
071	39	DAD,SP
047	27	DAA
306	C6	ADI
316	CE	ACI
326	D6	SUI
336	DE	SBI
LOGICAL GROUP		
240	A0	ANA,B
241	A1	ANA,C
242	A2	ANA,D
243	A3	ANA,E
244	A4	ANA,H
245	A5	ANA,L
246	A6	ANA,M
247	A7	ANA,A
250	A8	XRA,B
251	A9	XRA,C
252	AA	XRA,D
253	AB	XRA,E
254	AC	XRA,H
255	AD	XRA,L
256	AE	XRA,M
257	AF	XRA,A
260	B0	ORA,B
261	B1	ORA,C
262	B2	ORA,D
263	B3	ORA,E
264	B4	ORA,H
265	B5	ORA,L
266	B6	ORA,M
267	B7	ORA,A
270	B8	CMP,B
271	B9	CMP,C
272	BA	CMP,D
273	BB	CMP,E
274	BC	CMP,H
275	BD	CMP,L
276	BE	CMP,M
277	BF	CMP,A
007	07	RLC
017	0F	RRC
027	17	RAL
037	1F	RAR
057	2F	CMA
067	37	STC
077	3F	CMC
346	E6	ANI
356	EE	XRI
366	F6	ORI
376	FE	CPI
BRANCH GROUP		
302	C2	JNZ
312	CA	JZ
322	D2	JNC
332	DA	JC
342	E2	JPO
352	EA	JPE
362	F2	JP
372	FA	JM
304	C4	CNZ
314	CC	CZ
324	D4	CNC
334	DC	CC
344	E4	CPO
354	EC	CPE
364	F4	CP
374	FC	CM
300	C0	RNZ
310	C8	RZ
320	D0	RNC
330	D8	RC
340	E0	RPO
350	E8	RPE
360	F0	RP
370	F8	RM
303	C3	JMP
311	C9	RET
315	CD	CALL
307	C7	RST 0
317	CF	RST 1
327	D7	RST 2
337	DF	RST 3
347	E7	RST 4
357	EF	RST 5
367	F7	RST 6
377	FF	RST 7
STACK, I/O AND MACHINE CONTROL GROUP		
333	DB	IN
323	D3	OUT
166	76	HLT
000	00	NOP
343	E3	XTHL
301	C1	POP B
321	D1	POP D
341	E1	POP H
361	F1	POP PSW
305	C5	PUSH B
325	D5	PUSH D
345	E5	PUSH H
365	F5	PUSH PSW

Appendix.

```
000     0000    LXI,H     041    21
001     0001              123    53     goes in L
002     0002              000    00     goes in H
```

Program 2.

MOVE INDIRECT TO B REGISTER
MOV B,L 105 45

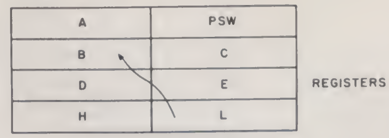


Fig. 6.

```
000     0000    LXI,B     001    01
001     0001              123    53     goes in C
002     0002              000    00     goes in B
```

Program 3.

31 hex) instruction. We cannot load either of the SP pairs with MVI instructions. However, there is another way, which we'll get to later.

We can also move data from any 8-bit register to any other, or to or from any memory location designated by the memory address in the HL pair. Here's an example of a register-to-register move, then the table of all possibilities.

To move data from register B to register C we use

MOV C,B 110 48

Thus the receiving register is listed first in the mnemonic, then the sending register. At this time we might note that when we move data from one register to another, the data still remains in the sending register (see Fig. 6).

Thus, using the octal example, if we have 123 in the B register and 156 in the C register and use the MOV C,B (110) instruction, we end up with 123 in the C register (moved from the B register) and 123 in the B register (it's still there). The 156 in the C register is gone forever, having been replaced by the 123 in the B register.

The MOV instructions follow in order: B, C, D, E, H, L, M, A. Thus, first MOV B,B, then MOV B,C, then MOV B,D, etc., until MOV B,A. The next group would be MOV C,B through MOV C,A, then MOV D,B through MOV D,A, until we finish with MOV A,B through MOV A,A. See the MOV instructions in the appendix for a list of all instructions. The octal instruction codes are consecutive from 100 to 177; the hex run from 40 to 7F.

See what I mean about how it is easier to memorize the mnemonics and codes if the codes are in octal? They follow a logical pattern (see appendix).

This covers most of the ways we can move data between registers and between memory locations and registers. But there are a few more you will find useful.

To store data in the A register into memory where the address is in the BC register pair, use:

STAX B 002 02

To load the A register from the memory location in the register pair BC, use:

LDAX B 012 0A

To store the A register into the memory location stored in the register pair DE, use:

STAX D 022 12

To load the A register from the memory location stored in register pair DE, use:

LDAX D 032 1A

To store the L register directly into any memory location, use:

SHLD 042 22

followed by the split octal address of the desired memory location. Thus, to store L in memory location 012437 (025/037 split octal, 151F hex), use:

```
SHLD     042     22
         037     1F
         025     15
```

Remember, low half first! The H register is automatically loaded into the following memory location.

To load the L register from any address, use:

LHLD 052 2A

followed by the split octal or hex address of the memory location desired. The H register is automatically loaded from the next address.

To store the A register into any address, use:

STA 062 32

followed by the split octal or hex address.

To load the A register from any memory location, use:

LDA 072 3A

followed by the split octal address.

Next month, in the second of three articles, we'll discuss the flags, learn how to do arithmetic and discuss the branch instructions, jump and call. Stay tuned. ■

Reader Service—see page 179

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Dr. Robert J. Cotter
The Johns Hopkins
School of Medicine
725 North Wolfe Street
Baltimore MD 21205

Programming the 1802

Dr. Cotter's last 1802 article appeared in the December 1978 issue. With this "welcome back" 1802 article, he explains how to input and output data, add subtract and multiply.

In "The Amazing 1802" (*Kilobaud*, No. 20, p. 102) and "Interfacing the Elf II" (*Kilobaud*, No. 24, p. 40), I described some hardware additions for expanding the Elf II. This time I'd like to share some programming techniques that will enable you to perform some simple arithmetic calculations on the Elf. This article will also introduce you to some methods for writing and calling subroutines you may wish to incorporate into your own programs.

If you did build the address decoder described in the latter article, you will find it easier to write and debug the programs and subroutines described below, since you can step up to the correct memory locations for entering the subroutines. If you did not, then have no fear, since all of the programs in this article have been written on the original 256 memory locations that come with the basic Elf II.

In Table 1 I have listed a subset of the 1802 instructions necessary for writing all of the programs in this article. Only one- and two-byte instructions are used, since the three-byte instructions are used for branching onto additonal (256 byte) pages of memory. I've also included the "level 1" mnemonics so you may translate the programs into the appropriate op code if you are using a different computer.

Before we begin programming, recall also that, in addition to the 256 8-bit memory locations, the Elf II has sixteen 16-bit registers and the 8-bit special purpose registers N, P, X and D. The 16-bit registers point to memory locations; the N, P and X registers point to the 16-bit registers; and the D register is used for arithemetic and logic operations.

decimal	hexadecimal	binary
75	4B	0100 1011
+58	+3A	+0011 1010
133	85	1000 0101

Example 1.

location	bytes	comments
00	F8 4B	4B→D
02	FC 3A	3A + D→D,DF
04	52	D→M(R2)
05	E2	R2 = RX
06	64	M(RX)→hex displays

Example 2.

How to Add Two Numbers

After I finished soldering my Elf II, my first inclination was to try to add two numbers together, even though it is a lot easier on a calculator. It takes more steps on a microcomputer, and you have to think in hexadecimal and binary to understand what is going on. Example 1 shows the addition of two numbers, 75 and 58.

The simplest way is to put the first number, 4B, into the D register using the LOAD IMMEDIATE instruction F8. We enter:

F8 4B

The D register then acts as an *accumulator* so that when you add the number 3A to the contents of D using the ADD IMMEDIATE:

FC 3A

the D register will then contain the answer, which must now be read out on the displays.

The Elf II will output numbers only from memory locations (not registers). The 52 instruction will transfer our answer to the memory location pointed to by R2, one of the 16-bit registers. Output instructions, however, will only fetch data pointed to by the register designated by the 8-bit X register. An E2 instruction places a 2 in register X, so that R2 = RX. A 64 instruction puts the answer on the displays. The whole program is shown in Example 2. If you enter the program and press the RUN switch, the hex displays will show the answer: 85.

So far, so good! But what happens if you add two numbers whose sum is greater than 256 (requiring more than 8 bits)? See Example 3. The binary addition produces a "carry" into the ninth bit. Fortunately, this bit is retained in a special register, the DF register, whenever the ADD IMMEDIATE command, FC, is used. A rewrite of our program for this addition is shown in Example 4. We have added three new steps that test DF for a "carry" bit and turn on the LED to indicate the carry.

Improving the Program

We need to improve the program. In step 04 we momentarily placed our answer in memory, and in steps 05 and 06 we designated this location as the source of our output display. This location is determined by R2, which may be pointing to any arbitrary location when the Elf is turned on. It may, in fact, write the answer in one of the program locations and erase

Op Code	Mnemonic	Name	Operation
1N	INC	INCREMENT REG N	RN + 1
2N	DEC	DECREMENT REG N	RN − 1
8N	GLO	GET LOW REG N	RN.0→D
9N	GHI	GET HIGH REG N	RN.1→D
AN	PLO	PUT LOW REG N	D→RN.0
BN	PHI	PUT HIGH REG N	D→RN.1
7A	REQ	RESET Q	0→Q (light off)
7B	SEQ	SET Q	1→Q (light on)
DN	SEP	SET P	N→P
EN	SEX	SET X	N→X
4N	LDA	LOAD ADVANCE	MN→D,RN + 1
5N	STR	STORE VIA N	D→MN
F0	LDX	LOAD VIA X	MX→D
F1	OR	OR	MX OR D→D
F2	AND	AND	MX AND D→D
F3	XOR	EXCLUSIVE-OR	MX XOR D→D
F6	SHR	SHIFT RIGHT	shift D right LSB→DF
76	SHRC	SHIFT RIGHT WITH CARRY	rotate D right LSB→DF, DF→MSB
FE	SHL	SHIFT LEFT	shift D left MSB→DF
7E	SHLC	SHIFT LEFT WITH CARRY	rotate D left MSB→DF, DF→LSB
F4	ADD	ADD	MX + D→DF,D
74	ADC	ADD WITH CARRY	MX + D + DF→DF,D
F5	SD	SUBTRACT D	MX − D→DF,D
75	SDB	SUBTRACT WITH BORROW	MX − D − $\overline{DF}$→DF,D
C4	NOP	NO OPERATION	continue
6N	OUT	OUTPUT (N = 1 − 7)	MX→BUS, RX + 1
64		(N = 4)	MX→hex display
6N	INP	INPUT (N = 9 − F)	BUS→D,MX
6C		(N = C)	keyboard→D,MX
30 MM	BR	UNCOND SHORT BRANCH	GO TO MM
31 MM	BQ	SHORT BRANCH IF Q = 1	GO TO MM if Q = 1
39 MM	BNQ	SHORT BRANCH IF Q = 0	GO TO MM if Q = 0
32 MM	BZ	SHORT BRANCH IF D = 0	GO TO MM if D = 00
3A MM	BNZ	SHORT BRANCH IF D≠0	GO TO MM if D≠00
33 MM	BDF	SHORT BRANCH IF DF = 1	GO TO MM if DF = 1
3B MM	BNF	SHORT BRANCH IF DF = 0	GO TO MM if DF = 0
37 MM	B4	SHORT BRANCH IF EF4 = 1	GO TO MM if INPUT switch is down
3F MM	BN4	SHORT BRANCH IF EF4 = 0	GO TO MM if INPUT switch is up
F8 KK	LDI	LOAD IMMEDIATE	KK→D
F9 KK	ORI	OR IMMEDIATE	KK OR D→D
FA KK	ANI	AND IMMEDIATE	KK AND D→D
FB KK	XRI	XOR IMMEDIATE	KK XOR D→D
FD KK	SDI	SUBTRACT D IMMEDIATE	KK − D − $\overline{DF}$→DF,D
FC KK	ADI	ADD IMMEDIATE	KK + D→DF,D

Table 1. COSMAC 1802 instruction sheet.

an instruction! Therefore, we will need to set R2 to point to some location well beyond the program.

Also, it is inconvenient, to say the least, to have to write a new program for each set of additions. Therefore, we will rewrite our program so that after execution is begun it awaits two operands from the keyboard, performs the computation, displays the answer and resets the program for the next computation. Program A gives the listing for such a program.

Step 1 sets R2 to point to location A0. R2 is called the "stack pointer," which we will set at A0 for all the programs in this article. All variables will then be located in memory beginning at this location and may be fetched as they are used in computations. Step 2 resets the carry register, DF, by loading 00 into the D register and then shifting 0 into DF. This is necessary since DF may contain a logical "1" when the computer is turned on. Step 3 designates our stack pointer, R2, as the output register.

Steps 4 to 6 illustrate the technique for accepting variables from the keyboard during execution. There are two loops (at steps 4 and 5) that wait for the INPUT switch to be depressed and released. If a number has been entered on the keyboard before pressing the INPUT switch, the instruction 6C will place that number into D and in the first position on the stack, in this case, A0. The 7A instruction resets Q, since it may be ON from a previous

decimal	hexadecimal	binary
58	3A	0011 1010
+ 242	+ F2	+ 1111 0010
300	12C	1 0010 1100

Example 3.

location	bytes	comments
00	F8 3A	3A→D
02	FC F2	F2 + D→D,DF
04	52	D→M(R2)
05	E2	X→2
06	64	M(RX)→hex displays
07	33 0A	GO TO 0A if DF = 1
09	00	STOP
0A	7B	Q→ON

Example 4.

computation. The 64 instruction displays the number we have just entered so that we can verify that it was entered correctly.

Steps 9 to 11 are used to accept the second operand and copy it into D and onto A1, the second position on the stack. The 64 instruction again verifies this number on the displays.

Addition will not take place until the INPUT switch has been depressed and released one more time (steps 13, 14). In step 15 the stack pointer returns to the top of the stack and adds (instruction F4) the number in location A0 with the contents of D (which still holds the second operand). The instructions 52 and 64 read out the answer, and the remaining steps test the carry register, DF, before returning the program for the next computation.

Try the program out using the previous examples. Press: RUN; 4B INPUT; 3A INPUT; INPUT. The display will read "85" and the LED will be off. Next, enter: 3A INPUT; F2 INPUT; INPUT. The displays will show "2C" and the LED will be on, indicating a carry.

Double-Precision Arithmetic

It is common in computer computations to work in "double precision." For an 8-bit computer this means working

Location	Bytes	Step	Comments
0000	F8 A0 A2	1	AO→D, D→R2.0
03	F8 00 F6	2	00→D, shift D right
06	E2	3	2→X
07	3F 07	4	GO TO 07 if INPUT switch is up
09	37 09	5	GO TO 09 if INPUT switch is down
0B	6C	6	keyboard bytes→D, M2
0C	7A	7	reset Q
0D	64	8	M2→hex display
0E	3F 0E	9	GO TO 0E if INPUT switch is up
10	37 10	10	GO TO 10 if INPUT switch is down
12	6C	11	keyboard bytes→D, M2
13	64	12	M2→hex display
14	3F 14	13	GO TO 14 if INPUT switch is up
16	37 16	14	GO TO 16 if INPUT switch is down
18	22 22	15	R2 − 1, R2 − 1
1A	F4	16	MX + D→DF,D
1B	52	17	D→M2
1C	64	18	M2→hex displays
1D	33 21	19	GO TO 21 if DF = 1
1F	30 00	20	GO TO 00
21	7B	21	Q→ON
22	30 00	22	GO TO 00

Program A. Addition program.

Memory Allocation

0000-003F	MAIN PROGRAM used for reading in variables, determining the type of computation and displaying answers
0040-0049	ADD subroutine
0050-0059	SUBT subroutine
0060-0080	MULT subroutine
00A0-00A4	stack pointer storage of operands, answers and subroutine locations
	A0 operand 1, high-order byte
	A1 operand 1, low-order byte
	A2 operand 2, high-order byte
	A3 operand 2, low-order byte
	A4 subroutine to be called

Register Allocation

R2 = R(SP)	the stack pointer
R3 = R(PC)	the program counter, used to call subroutines
R5 = R(RET)	stores return location for main program
RF = R(ACC)	accumulator register; contains one of the operands and the answer.

Table 2.

with 16 bits, which gives an effective computation range from 0 to 65,535. Because the D register is only 8 bits long, it can no longer be used as the accumulator. Instead, the 16-bit register, RF, will be used as the accumulator, R(ACC), while R2 will still serve as the stack pointer, R(SP).

Also, at this stage we want to think ahead a little. We will want to write programs for subtraction and multiplication, as well as addition. We can cut down on our programming if we write all of these operations as subroutines. Therefore, we will first turn our attention to writing a program that will input the variables, store them on a stack, call the appropriate subroutine and display the answers. This will be the MAIN program.

Table 2 shows how we will organize the memory locations to accommodate the MAIN program, the subroutines and the variables stored via the stack pointer. We will also designate two new registers for subroutining. Register R3 will be used to point to a subroutine, while register R5 will store the return location when the subroutine has been executed.

decimal	hexadecimal
39,730	9B32
+49,905	+C2F1
89,635	15E23

Example 5.

The MAIN Program

The program to input and output the variables is listed as Program B. Step 1 sets the stack pointer, R(SP), while steps 2 and 3 clear DF and Q. Steps 4 to 6 should now be familiar as the loop that awaits the variables that will be copied onto the stack beginning at location A0. The program will accept two double-precision operands and store these in locations A0 to A3. It also accepts a fifth number (40, 50 or 60) to indicate which subroutine (ADD, SUBT or MULT) is to be executed.

Steps 7 to 9 test to see if the stack pointer has reached A5. It then stops accepting variables and continues execution. Instruction 22 returns the stack pointer to A4, which contains the address of the subroutine. In step 11 this is loaded into the pointer register, R3. Step 12 sets the return location into R5.

In step 13, the stack pointer is returned to the top of the stack at A0 and in the next two steps loads the high and low bytes into the 16-bit accumulator register. The stack pointer is pointing to A2 when the D3 instruction sends the program pointer to the appropriate subroutine location.

Step 17 is the return location from the subroutine. The instruction D0 restores control of the program pointer by the register R0. Steps 18 and 19 place

the high-order byte of the answer (from the accumulator register) into memory and onto the output displays, while steps 24 and 25 do the same for the low-order byte after the INPUT switch has been depressed and released.

The 7B instruction in step 21 lights the LED if there has been a carry, and steps 26 to 28 return the program for a new computation if the INPUT switch is depressed one more time. The MAIN program can be used with any of the subroutines that follow.

The ADD Subroutine

Addition is accomplished in the D register by adding the low-order bits from memory and the accumulator register first, returning the 8-bit result to the accumulator and then repeating the process for the high-order bits. The first addition uses the F4 instruction (ADD), but since this addition may result in a "carry" into the ninth bit (register DF), the instruction 74 (ADD WITH CARRY) is used in the addition of the high-order bits. A carry after the second addition is tested in the MAIN program.

The ADD subroutine is listed as Program C and begins at location 40. Remember that upon entering the subroutine the stack pointer is aimed at location A2. The first step in the subroutine increments R2 to fetch the low-order bits first. At

Location	Bytes	Step	Comments
0000	F8 A0 A2	1	set R(SP)
03	F8 00 F6	2	clear DF
06	7A	3	reset Q
07	3F 07	4	wait for INPUT to be depressed
09	37 09	5	wait for INPUT to be released
0B	E2 6C 64	6	accept inputs from keyboard, store, display and increment R(SP)
0E	82	7	R2.0→D
0F	FB A5	8	D XOR A5
11	3A 06	9	GO TO 06 if D≠0
13	22	10	decrement R(SP) to location A4
14	F0 A3	11	M2→D; D→R3.0 (subroutine pointer)
16	F8 23 A5	12	set return location in R5
19	F8 A0 A2	13	reset R(SP) to A0
1C	F0 BF 12	14	M2→RF.1; R2 + 1
1F	F0 AF 12	15	M2→RF.0; R2 +
22	D3	16	call subroutine; 3→P
23	D0	17	0→P
24	9F 52	18	RF.1→D, D→M2
26	64	19	display high-order bytes of answer
27	3B 2A	20	GO TO 2A if DF = 0
29	7B	21	light Q
2A	3F 2A	22	wait for INPUT to be depressed
2C	37 2C	23	wait for INPUT to be released
2E	8F 52	24	RF.0→D, D→M2
30	64	25	display low-order byte of answer
31	3F 31	26	wait for INPUT to be depressed
33	37 33	27	wait for INPUT to be released
35	30 00	28	return

Program B. MAIN program.

Location	Bytes	Step	Comments
0040	12	1	R2 + 1
41	E2	2	x→2
42	8F	3	RF.0→D; fetch R(ACC) low-order bits
43	F4	4	M2 + D→D,DF; add low-order bits
44	AF	5	D→RF.0; store result in R(ACC)
45	22	6	R2 − 1
46	9F	7	RF.1→D; fetch R(ACC) high-order bits
47	74	8	M2 + D + DF→D,DF; add high-order bits and carry
48	BF	9	D→RF.1; store result in R(ACC)
49	D5	10	return to MAIN program

Program C. Add subroutine.

the end of the subroutine, the instruction D5 makes register R5 the program counter. Its initial location was set by the MAIN program as the return address.

Let's add two double precision numbers, represented in decimal and hexadecimal, to see how the program works (see Example 5). Enter both the MAIN program and the ADD subroutine into the computer and press the RUN switch. Then enter: 9B INPUT, 32 INPUT, C2 INPUT, F1 INPUT, 40 INPUT. The last entry is the location of the subroutine and indicates that you wish to add the two numbers.

The displays will show the number 5E and the LED will be lit, indicating the carry. If you press the INPUT switch again, the displays will read 23. One more depression of the INPUT switch readies the program for the next computation.

The SUBT Subroutine

The subroutine for subtraction is listed as Program D and is similar to the ADD subroutine. In this case, however, subtraction of the low-order bits is accomplished with instruction F5 (SUBTRACT), while the high-order bits use 75 (SUBTRACT WITH BORROW). Whenever a borrow occurs, DF will be set to "0." When it does not, DF = "1." Again, let's try an example:

```
  A217
- 3C85
  6592
```

Enter the SUBT subroutine, press the RUN switch and then enter: 3C INPUT, 85 INPUT, A2 INPUT, 17 INPUT, 50 INPUT. Note that the subtrahend is entered first and that the last input calls the SUBT subroutine. The display will show 65, and depressing the INPUT switch will give the low-order byte 92. The LED will be lit, indicating that DF = 1, that no borrow has occurred and that the answer is positive.

Suppose then, that we subtract a larger number from a smaller one:

```
  3C85
- A217
- 6592
```

Location	Bytes	Step	Comments
0050	12	1	R2 + 1
51	E2	2	x→2
52	8F	3	RF.0→D; fetch R(ACC) low-order bits
53	F5	4	M2 – D→D,DF; subtract low bits
54	AF	5	D→RF.0; store result in R(ACC)
55	22	6	R2 – 1
56	9F	7	RF.1→D; fetch R(ACC) high-order bits
57	75	8	M2 – D – $\overline{DF}$→DF,D; subtract with borrow
58	BF	9	D→RF.1; store result in R(ACC)
59	D5	10	return to MAIN program

Program D. Subt subroutine.

Location	Bytes	Step	Comments
0060	F8 00 AF	1	clear accumulator
63	22	2	R2 – 1
64	E2	3	x→2
65	F0	4	M2→D
66	3A 69	5	GO TO 69 if D≠00
68	D0	6	return to MAIN program
69	F6	7	shift D right
6A	52	8	D→M2
6B	12	9	R2 + 1
6C	3B 77	10	GO TO 77 if DF = 0
6E	F8 73 A5	11	set return location for MULT
71	30 40	12	GO TO ADD subroutine
73	F8 77 A3	13	reset R3
76	D3	14	3→P
77	12	15	R2 + 1
78	F0	16	M2→D
79	FE	17	shift left; MSB→DF
7A	52	18	D→M2
7B	22	19	R2 – 1
7C	F0	20	M2→D
7D	7E	21	rotate D left; DF→LSB; MSB→DF
7E	52	22	D→M2
7F	30 63	23	GO TO 63

Program E. Mult subroutine.

The answer will appear as 9A6E, and the LED will be off. This indicates that the answer is negative and that we have the "2's complement" of the correct answer. To get the negative result, subtract that number from 0000, and the display will read 6592 with the LED off (negative).

The MULT Subroutine

Multiplication in binary is done by shifting the multiplicand left and adding. Therefore, the MULT subroutine, listed as Program E, uses ADD as a subroutine. Also, since the multiplication of two 8-bit numbers produces a 16-bit answer, the subroutine used here will accept only 8-bit operands from the MAIN program.

The subroutine works as follows. The multiplier is placed in the D register and shifted right. DF is then tested. If DF = 1, then the multiplicand is entered into the accumulator register. The multiplicand is then shifted left. The multiplier is shifted again and DF is tested. If DF = 1, then the ADD routine is called to add the new multiplicand to the accumulator, and the muliplicand is again shifted left. If DF = 0, no addition takes place, but the multiplicand is still shifted left.

The ADD subroutine is called by a GO TO statement rather than a program pointer, since, unlike the MAIN program, MULT will always call this subroutine. This means that it enters the ADD subroutine still under the control of R3. Before entering the ADD subroutine, however, MULT changes the R5 location so that the ADD subroutine will return to location 73 and not the MAIN program.

Return to the MAIN program occurs when the multiplier equals zero. Return is accomplished by placing control of the program in the R0 register, which is pointing to the next location in the MAIN program from where we left it.

Let's try an example. Suppose we wish to perform the following multiplication:

```
   85
 × AB
 58D7
```

Enter the MULT subroutine, press the RUN switch and enter: 00 INPUT, 85 INPUT, 00 INPUT, AB INPUT, 60 INPUT. 58 and D7 will appear on the displays.

Where Do We Go from Here?

All of this seems fairly complicated compared to what you can do on a simple, inexpensive calculator. However, there are several distinct advantages. First, the subroutines could be used to perform calculations on data that is being continuously fed to the computer through an A/D converter—or two separate inputs could be compared, with the sum or difference plotted using a D/A converter.

Using the techniques described here, you may also wish to write a division subroutine or expand the multiplication subroutine for double precision. You also may rewrite the MAIN program to solve an equation like y = ax + b. The main advantage that the microcomputer has over the programmable calculator is its ability to accept data from something other than a keyboard.

In future articles I plan to discuss several other things you can do with your Elf II: for example, memory expansion in 256, 1K or 4K steps will allow you to expand your computer at a rate you can afford; an autoranging A/D converter will automatically give you the most siginificant 8 bits, for many different signal levels. I have also recently purchased the COSMAC Evaluation Kit and plan to do a comparison of that system with the Elf II. I also plan an article on timing for generating waveforms and one on a Teletype interface. ■

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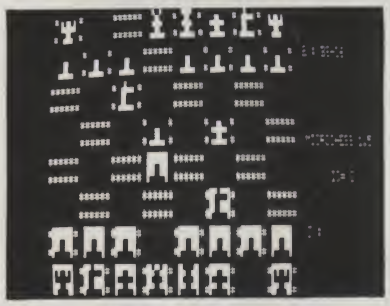
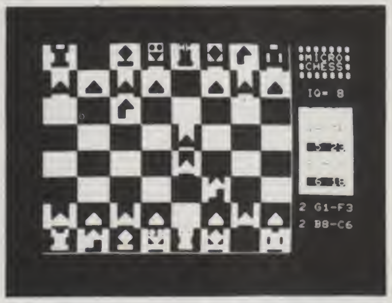

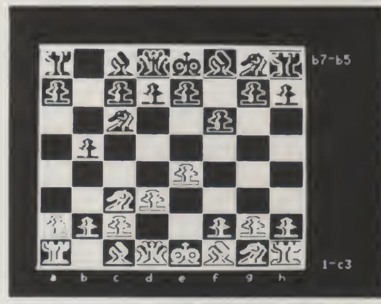

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Keyboard Interrupt for the TRS-80

Interact with moving graphics displays on the TRS-80.

One of the features than enticed me to purchase the TRS-80 was its capability for video graphics. I had been programming for nearly ten years (I have two DEC PDP/8s in my office and access to a PRIME 300), so I was no newcomer to computers. However, I had never had the opportunity to do any graphics.

One of the first things I did after unpacking the new machine, reading the instructions and powering up was to experiment with the display. It was initially fascinating just to turn dots on and off or to have the computer draw straight lines. Thoughts of fancy video games ran through my mind. I was disappointed to find that the manual gave me no apparent way to interact with a moving display, short of hitting the break key (which certainly would not do!). Dismayed, I turned to other programming and hoped that the future Level II BASIC would provide for this feature.

Several days later, after playing with the computer several hours a day, I suddenly realized that I did have an interrupt. Consider the following. Regardless of what the computer is doing, the cursor remains on the screen, and the keyboard is still capable of putting characters on the display. To verify this, try running the following program:

```
10 CLS
20 GOTO 20
```

While the computer is looping endlessly, try typing a few characters. Voilã! Even though the program does nothing with the characters, there they are on the screen. Now input the following:

```
10 CLS
20 PRINT AT 0,"";
30 SET(2,1)
40 GOTO 40
```

This program positions a dot just after the cursor and then enters an endless loop. While this is running, hit the space bar. The dot disappears! Now, if you include the IF POINT = instruction in the main loop of your program (so that the computer periodically examines that dot), you have all the necessary ingredients for a keyboard interrupt.

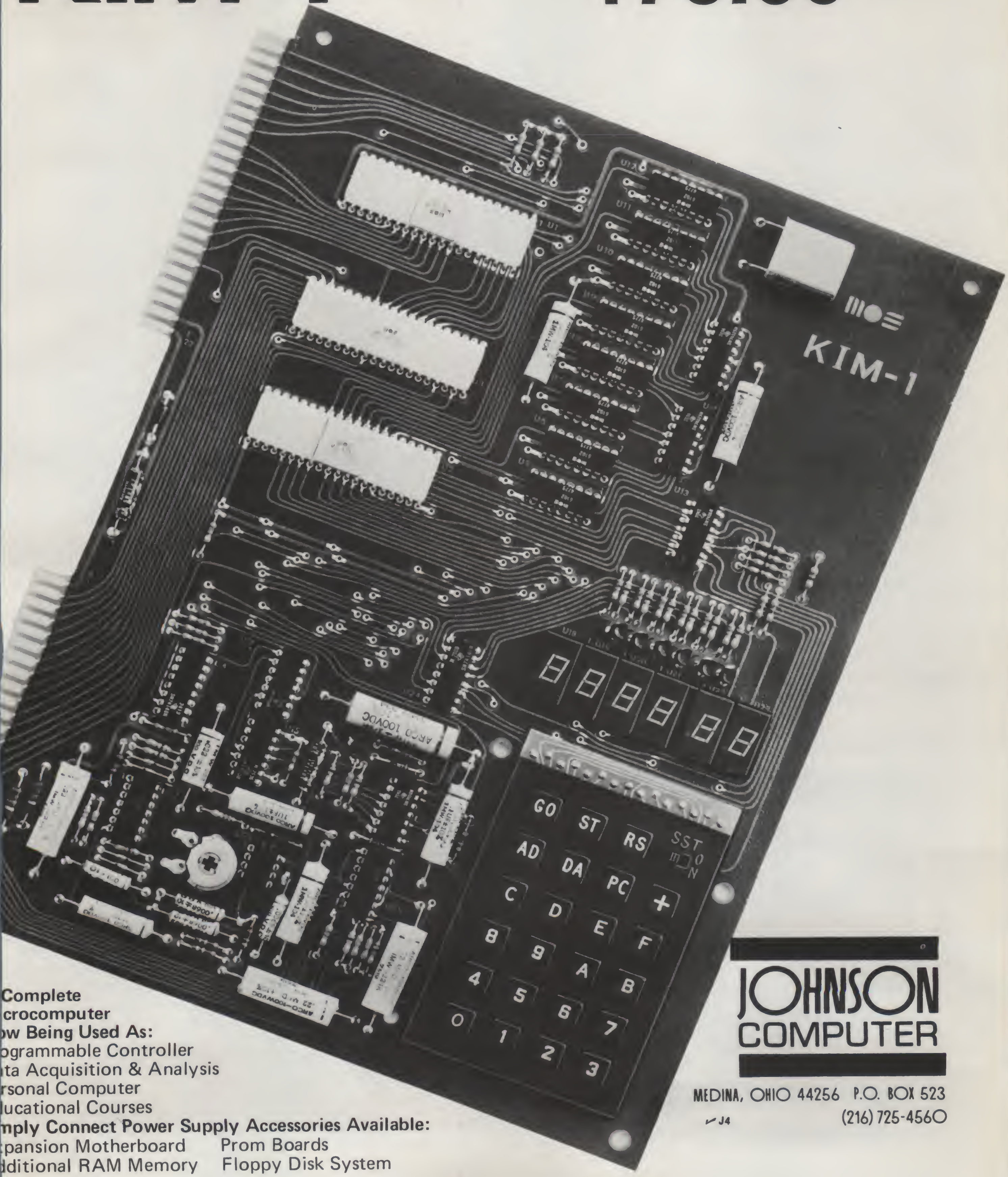
A simple sketch program that illustrates the whole concept (for clarity, no abbreviations have been used) accompanies this article. Take note that after using this interrupt, it is important to reposition the cursor and control dot, as in line 70 and 80.

With this idea added to your repertoire of programming tricks, you should have many hours of fun interacting with your moving graphic displays. ■

```
10 CLS
20 REM - STARTING POINT X,Y; DIRECTION RIGHT (Z)
30 REM - INITIALIZE INPUT LETTER VALUES
40 X=60: Y=20: Z=3
50 U=1: D=2: R=3: L=4
60 REM - POSITION CURSOR AND CONTROL DOT
70 PRINT AT 0, "HIT SPACE TO INTERRUPT";
80 SET(46,1)
90 REM - START OF LOOP
100 IF POINT (46,1)=0 GOTO 250
110 SET (X,Y)
120 ON Z GOTO 130, 160, 190, 220
130 REM - UP
140 Y=Y-1
150 GOTO 90
160 REM - DOWN
170 Y=Y+1
180 GOTO 90
190 REM - RIGHT
200 X=X+1
210 GOTO 90
220 REM - LEFT
230 X=X-1
240 GOTO 90
250 REM - DETERMINE DIRECTION AFTER INTERRUPT
260 PRINT AT 64, "UP=U DOWN=D RIGHT=R LEFT=L"
270 PRINT AT 128, "WHICH DIRECTION";
280 INPUT Z
290 PRINT AT 64, ""
300 PRINT AT 128, ""
310 GOTO 60
```

Sketch program.

KIM-I 175.00



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The OSI Model 500

"Ohio Scientific's Model 500 CPU comprises compromise between completeness and cost."

Over the past year the self-contained (almost one board) microcomputer has appeared in several forms and levels of sophistication. The MOS Technology KIM-1 represents one of the extremes in which the single board not only provides the 6502 CPU, RAM storage and PROM operating system (a monitor), but also supplies a hexadecimal keypad and display, as well as a speed-compensating cassette interface. Although this unit is almost entirely self-contained, requiring the addition of only an external power supply, it is a minimal system. The RAM memory is only 1K bytes in the basic unit, which, in addition to the I/O limitations, makes it very difficult to support higher level software (e.g., BASIC).

The Apple, Radio Shack TRS-80 and PET 2001 microcomputers offer improvements over this situation, but for a price. These machines come with some form of BASIC in PROM, along with a significant complement of RAM for program storage.

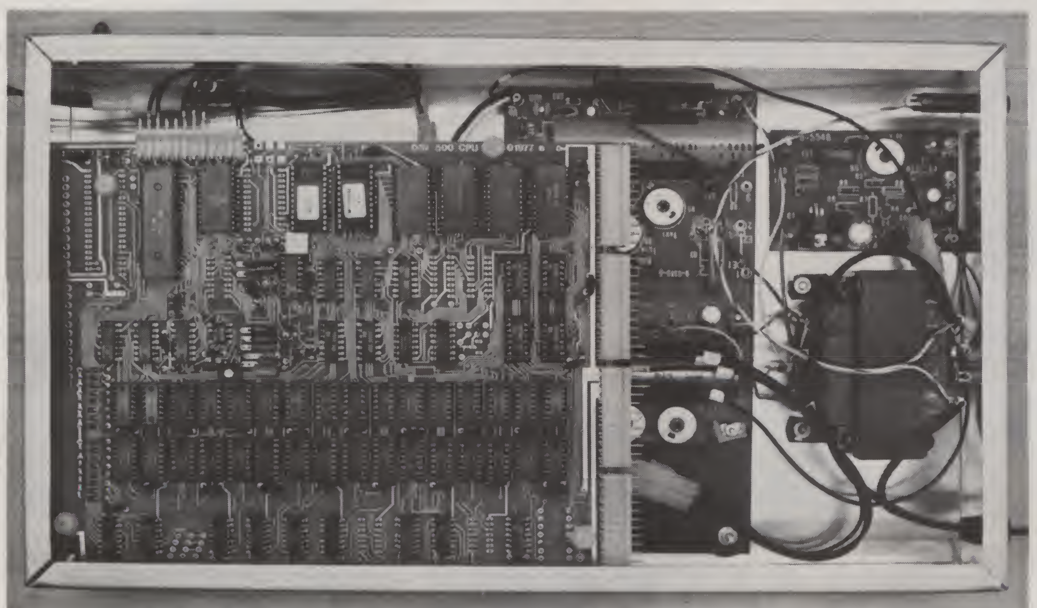

Photo 1. OSI Model 500 CPU board mounted in a BUD chassis box along with the required power supply.

The Apple is a very nice machine, which has color graphics and game controls, but it is the most expensive of the three computers. The PET 2001 is housed in an attractive enclosure, but has a keyboard that I find uncomfortable; the keys are too small and too close together, and several of the common keys are in remote positions. Also, according to a New York computer store, the originally advertised $600 4K RAM version is no longer available; only the $800 8K RAM unit can be ordered *prepaid*.

The TRS-80 outwardly appears to claim the low-cost end of the scale at a basic price of $400. This machine comes with 4K of RAM program storage space. However, once a video monitor and cassette recorder are added, the price is approximately equal to that of the originally advertised PET 2001, which included these features *and* contained a much better BASIC interpreter.

Enter the OSI 500

The Ohio Scientific Model 500 CPU provides a compromise between completeness and cost. It is a single board microcomputer having an assem-

Photo 2. The complete system. The computer itself is underneath the CT-64 terminal.

bled price of $300. It contains an 8K BASIC in PROM, an RS-232C or 20 mA current loop interface (both available), 4K of RAM and easy expansion capabilities. The user must provide the power supply and terminal. Obviously, the Model 500 is not an "appliance" computer, but it is an interesting basic microcomputer for the hobbyist. In addition, it can serve as the base for an industrial controller or data acquisition system because of the ready availability of an on-board parallel port and other expansion features.

In the following section the hardware attributes of the Model 500 will be discussed in rather general terms. An example of incorporating the board into a small system will be given, and the speed of the software will be examined in terms of mathematical function processing times.

Hardware Features

The OSI Model 500 CPU board includes the following basic features.

- Two 256-byte 1702 EPROMs containing a system monitor and a serial input/output controller.
- Four Signetics 2616 ROMs containing a version of BASIC written by Microsoft (the same people who wrote the corresponding Mits software).
- Four kilobytes of 2102 static memory.
- A 6502 microprocessor operated at 1 MHz.
- A Motorola 6850 ACIA (asynchronous communications interface adapter) based serial interface having both RS-232C and 20 mA current loop capabilities; 110 to 9600 baud.
- Provisions for a Motorola 6820 PIA (peripheral interface adapter) based parallel I/O port (the 6820 is provided by the user).
- Space for an additional 256 byte 1702 EPROM.
- Convenient pin-bus connectors (for power, expansion). These are similar to SWTP 6800 connectors.
- The majority of the integrated circuits are in sockets.

In addition, the CPU board comes with a 57-page hardware manual that is very complete and reasonably well written. The manual is presented in a modular "how to build" and "how it works" format. Prior to doing anything with the board, you should read the manual in its entirety. In doing so you will be rewarded with an errata sheet, which is hidden in Part V, Appendix ii. The manual also contains a considerable amount of discussion regarding troubleshooting. This treatment is a welcome change from the documentation I have been accustomed to in the past.

The power requirements for the board (including the 6820 PIA) are +5 volts at 2 amperes and −9 volts at 500 mA. Photo 1 shows the OSI Model 500 board mounted in a BUD chassis box along with the required power supply.

The 16X clock for the 6850 serial interface is derived from a 555 oscillator. The baud range spanned is 110 to 9600. The baud is chosen by jumpering to one of five pads to pick the approximate RC frequency components and then fine-tuning with a variable resistor (trim pot).

I selected the 300 baud pad and adjusted the trim to be in the center of the appropriate frequency range by observing the computer's output response to "reset." However, when the unit warmed up, the clock frequency drifted well out of the acceptable range. The baud should be adjusted when the unit is warm, or, better yet, the 16X baud clock existing in the external terminal should be routed to the CPU board and used instead of the 555 timer circuitry. The manual discusses how this may be done.

The addition of a 6820 16-line (e.g., eight in and eight out) par-

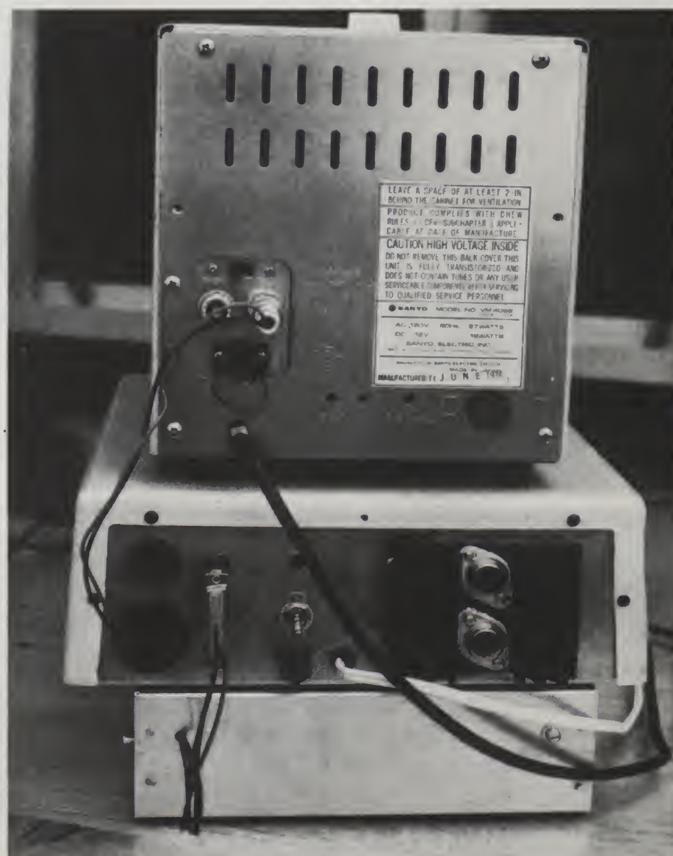

Photo 3. Back view of the system. The RS-232C output of the Model 500 CPU is connected directly to the CT-64 terminal, which is, in turn, connected to the video.

Function	Function Time (miliseconds)				Speed (/time) Ratio				
	Mits	OSI	North Star	North Star FP	Mits/NS	FP/NS	FP/OSI	FP/Mits	OSI/Mits
Division	7	3	16	2	2.3	8.0	1.5	3.5	2.3
Multiplication	4	2	5	2	1.2	2.5	1.0	2.0	2.0
Power	55	37	167	18	3.0	9.3	2.0	3.1	1.5
Sin/Cos	23	17	99	11	4.3	9.0	1.5	2.1	1.8
Square Root	46	33	92	4	2.0	23.0	8.2	11.5	1.4
Logarithm	19	14	99	9	5.2	11.0	1.6	2.1	1.4
Exponent	28	22	73	8	2.6	9.1	2.8	3.5	1.3
Mixed	160	143	521	60	3.3	8.7	2.4	2.7	1.1

Table 1. Incremental time to do function.

allel port appears to be straightforward, though I have not had a chance to implement it yet. All the circuitry required is presented on the board (upper left-hand corner of Photo 1) in terms of foil patterns. The address (F7XX) of the 6820 is decoded by an eight-input NAND gate (7430). Solder in the parts and the port will be in place. That is the easy part.

The user must supply the software for initializing and controlling the port, which is confusing for a beginner. Initialization and use are not discussed in the OSI manual, and reference is made to the appropriate Motorola manual. Note, the 6820 is also used on the Mits 4PIO board. The manual that comes with the Mits board is a good source of information, along with clarifications that have appeared in Mits' "Computer Notes" publication.

The required connections to the Model 500 board are the three power supply wires (+5, −9 and ground), the three I/O wires (RS-232C: receive, transmit and ground) and the two wires for the reset switch. Connection is very simple, as may be seen from Photo 1.

The Model 500 CPU board can be used to form the central unit in a small microcomputer system as shown in Photos 2 and 3 by adding an SWTP CT-64 video terminal and a video monitor. The CPU board is initialized via the reset button. The computer's response to this is "C/W/M?" which is the subject of the next section.

The PROM Monitor

There are two general versions of the monitor: one for the basic Model 500 serial I/O configuration and one for the optional OSI video board. The single board unit discussed here comes with the former. The CRT screen image on Photo 2 shows the computer response to being reset: "C/W/M?". In that case BASIC was called by answering with a "C." If instead the reply were "M," the monitor command mode would have been entered. The commands available, and their implementations, follow.

P: Sequentially displays memory contents in lines containing eight hexadecimal bytes. The display continues until any key is depressed on the keyboard. For example, P0000 (hex) displays memory starting at the origin.

R: Returns monitor to command mode.

L: Changes memory starting at the location specified. For example, L0000 A1 A7 F6 01. Escape is via "R."

G: Go command. For example, G0000 will start execution at 0000.

The OSI manual contains little information regarding machine-language programming other than specifying where the character input/output and similar routines are. The user is referred to the MOS Technology Programming Manual and the Ohio Scientific Small Systems Journal for information. The former is the manual that comes with the KIM-1 microcomputer; it is very complete. The latter is an OSI publication that is (in my opinion) highly overpriced at $1.50 per issue. Neither of these comes with the Model 500, and they must be obtained separately.

A better source than the OSI journal for machine-language software information is the informal publication called "KIM-1 User's Notes" or "The First Book of KIM." Personally, I find no pressing need to do machine-language programming because of the presence of a good BASIC resident in ROM.

Interpreter	Relative Speed
North Star Floating Point	1.0
Ohio Scientific	0.54
Mits 8K (Extended)	0.35
North Star (Version 6, Release 2)	0.13

Table 2. Relative function calculating speeds of the Mits, North Star and OSI BASIC interpreters.

OSI BASIC

The eight-kilobyte BASIC interpreter resident in ROM on the Model 500 CPU board was written by Microsoft. Although an instruction manual was not included with the board, this interpreter appears to be similar to Mits 8K BASIC, which was also written by Microsoft. Even the initialization questions (see the CRT display on Photo 2; "C/W/M?" was answered with a "C"; "W" does the same) are similar. This software is unquestionably better than TRS-80 Level I BASIC.

Reviews of Mits 8K BASIC can be found elsewhere. My interest in software is from a mathematical calculation perspective. In an earlier article presented in the August 1978 *Kilobaud* ("Mits vs North Star: which is faster?" p. 44), I compared the mathematical function processing times for Mits 8K, regular North Star and North Star Floating Point BASIC. I repeated this comparison for the OSI Model 500 with the results shown in Table 1.

Compared with North Star BASIC run in conjunction with the North Star Floating Point Board, which is very fast, the average relative speeds of the other three interpreters are as shown in Table 2.

The conclusion from the two tables is that the Ohio Scientific interpreter is very fast in its ability to perform mathematical calculations. A comparison between OSI and Mits is fair in that each has the same accuracy: six digits. OSI has claimed a 20 percent speed advantage in the literature. The two North Star examples are at a disadvantage as the mathematical functions are calculated to greater accuracy: eight digits. In any case, OSI fairs well in the comparison.

Conclusion

The OSI Model 500 CPU board offers an attractive set of features for the hobbyist or designer who wishes to begin with a small system that is in a class between the KIM-1 and Altair/Imsai. The Model 500 is definitely more powerful than the KIM-1 . . . more than might be expected from the small difference in price.

The major additional cost in assembling a small system using this board is the required input/output terminal and the optional cassette interface. These could probably be obtained for perhaps another $200 to $300. The $80 SWTP ACR-30 would be a good choice for the cassette interface. If the object were to obtain the capabilities of a PET 2001 and go no further, it would be difficult to justify not simply buying a PET. The lure of the OSI Model 500 is in its use as a basic building block for the experimenter. ■

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2. Update employee codes.
3. Break-in attempt report.
4. System usage report.
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C80

Reader Service—see page 179

Sleep Better with a Microcomputer

This knowledgeable author suggests utilizing the microcomputer in medical applications.

Phil Wilkinson
University of California, SF
School of Medicine
San Francisco CA 94143

The patient lay anesthetized on the operating table as the surgeons worked in the open cavity of his chest. Behind the sterile barrier at the head of the table, the anesthesiologist watched a bar graph on a color video screen. Noting that "peripheral vascular resistance" was higher than normal, he punched the alphanumeric keyboard below the screen, requesting a trend display of this parameter. The screen display changed to a slowly rising line showing the values of peripheral vascular resistance for the previous two hours.

He punched the keys again, requesting trends of left atrial pressure and central venous pressure be added to the display. Both of the pressure tracings trended downward in parallel fashion. Satisfied, he turned and spoke to the surgeon.

"I'm going to increase the transfusion rate. We're getting a little behind on blood loss here."

He touched the keyboard again and watched the display show the intake of blood and salt solutions and loss of urine and blood since the operation began. Then, in response to a prompt from the computer, he punched more keys and added a correction for fluid loss into the spaces between the body tissues. He frowned slightly as the computer confirmed a net excess of fluid loss since the beginning of the operation.

As he watched, the display changed and a bell sounded, reminding him that it was 40 minutes since the last dose of muscle-relaxant drug. According to calculated drug kinetics and measured muscle stimulation, the patient had recovered 70 percent of his muscle power and was likely to move, although remaining unconscious. The computer further suggested that the anesthesiologist administer 2 mg of the drug, which would paralyze the patient for another 40 minutes.

He pressed the acknowledge key and, before giving the drug, quickly glanced at the progress of surgery. Pressing more keys, he reviewed the current concentration of halothane anesthetic being administered and the projected tissue concentrations, considering the patient's age, sex, height, weight and respiratory exchange. He spoke to the surgeons.

"Old Hal here suggests some more relaxation. You going to take more than another 40 minutes?"

The surgeons laughed.

"Better keep old Hal happy."

"OK."

The anesthesiologist gave the suggested dose of drug. Then, after changing the screen mode, he reviewed the anesthetic record of drugs administered, blood pressures, heart rate, temperatures and cardiac output. He typed on the keyboard and watched as the computer added the drug he had just injected to the display.

"You think you will be about another hour with the surgery?"

"Sounds about right."

He punched the keys again, instructing the computer to start the process of waking the patient up with a projected finishing time of one hour. The computer calculated the kinetics of elimination of halothane for this patient and the dose of reversal agents to overcome the muscle paralysis. The screen display changed and a bell sounded.

"Reduce halothane to 0.9 percent inspired now. Draw up 5 mg neostigmine and 2 mg atropine for administration in 45 minutes. I will remind you when it is due."

Slowly the anesthesiologist turned to the row of drugs and syringes behind him and began the gradual sequence of awakening his patient.

Can It Work?

Does this sound like a scene from a science-fiction movie? I hope not, because with the microprocessor-based computer, the above scene is easily within the abilities of today's technology.

There are many millions of dollars invested in computers in the health-care industry, and industry projections show that health care will become an increasingly important area of application for computers as other areas become saturated. Despite this, computers in medicine have never fulfilled the bright future that they seemed to hold, and the computer in many centers has been confined to patient billing and other business applications, or the automated control of laboratory tests and reports.

Programs designed to help in the diagnosis of disease and patient management have been disappointing. Despite thousands of man-hours and millions of dollars spent, programs to detect electrocardiographic rhythm abnormalities do not perform better, and often perform worse, than a human interpreter. Similarly, the results from several centers where minicomputers have been used to automate intensive-care-unit management of patients do not show significant improvement in patient morbidity or mortality.

Measured	Calculated from measured parameters
Blood pressures	Peripheral vascular resistance
Heart rate	Pulmonary vascular resistance
Temperatures-rectal	Stroke work and power
-esophageal	
Cardiac output	Rate-pressure product
Central venous pressure	Minute volume of respiration
"Wedge" pressure	Pulmonary compliance
Urine output	Physiological dead space
Respiratory tidal volume	Tension time index
Inspired oxygen concentrations	Systolic time intervals
Expired carbon dioxide concentrations	Respiratory work and power
Blood oxygen saturation	Power spectrum analysis of the electroencephalogram
Anesthetic concentrations	
Volume of intravenous fluids	
Electrocardiographic S-T segment changes	
Electroencephalogram	
Airway pressures	
Airway flow	

Table 1. Parameters a microcomputer could help monitor.

Why is this? I believe the crux of this problem is the inability to define medical treatment and management decisions in terms of physical laws and processes. There just is not enough reliable data to make definitive projections about individual patients and predict their medical course.

The situation is quite different from the physical sciences, where the systems are much less complex and are better understood. For example, controlling a spacecraft, where all of the systems are known and understood, as are the laws of orbital and celestial mechanics, becomes a relatively easy task of simulation and projection compared to biological systems. Not all biological systems are known; most are poorly understood; and their overall integration is even less well understood.

Reasons for Optimism

Why, then, am I excited about the future role of computers, particularly the microprocessor, in anesthesiology? There are several reasons.

To begin with, anesthesia and surgery are two specialties where there is a much closer, and in some ways simpler, cause-and-effect relationship between what the physician does and what happens to the patient. All patients will go to sleep when the anesthesiologist gives them thiopental, but not all patients will improve when the cardiologist gives them digoxin.

Hence one way of describing the sequence of events in anesthesia is to say that it is a continuing series of actions and reactions with a close temporal linkage not seen in other areas of medicine.

In addition, while the number of drugs used is large, it is not overwhelming, and the ways in which patients respond to anesthetics are restricted. We are not dealing with a spectrum of diseases that require a 700-page book just to describe the symptoms and physical signs, and another 700-page book to summarize the treatments.

Another reason is that anesthesia is a specialty involving close patient monitoring of many different physiological parameters, an area particularly suited to computer processing and automation. In fact, it is my belief that current trends towards increasingly complex patient monitoring have reached the point where computer automation of some of the calculations has become a necessity.

Why microcomputers and not the standard IBM behemoth? Because of its smaller cost, size and complexity, the microcomputer makes it possible for the small-town anesthesiologist to own a computer and use it successfully, without having to pay the salaries of programmers and take out costly maintenance contracts.

Applications and Examples

Has the microprocessor been used in this area? Only in a few limited applications. One of the most exciting of these is a system developed in the department of anesthesia at U.C., San Diego, by Dr. N. Ty Smith. This device has an Intel 8080 microprocessor with four analog input channels and uses either alphanumerics or a strip chart recorder for display. He has used this device for trend analysis, processing signals from an electroencephalogram, calculating how much blood the heart is pumping and other parameters that indicate the well-being, or otherwise, of the heart. This is a unique device; however, the things that it does could be easily performed by an off-the-shelf microprocessor-based computer with analog-to-digital inputs.

We at U.C.S.F. have a Motorola 6800-based device that accepts three analog channels, generating information about the resistance to blood flow, what the blood flow from the heart is, how well the heart is performing and whether the heart is itself receiving an adequate blood supply. Programs are in ROM, and already I regret that we cannot easily change the programs and modify them. I believe that many of the monitoring functions are ultimately best handled with ROM, but a more flexible system is needed in the development stages.

Why do patients need monitoring under anesthesia? Think of an anesthetic as a reversible poison, because that is exactly what it is. Curare and eserine, both used in medicine, are a South American arrow poison and an African "trial by ordeal" drug, respectively. "Trial by ordeal" means that if you did not die after taking the drug, you were obviously innocent of the crime of which you were accused.

Inhalation anesthetic drugs such as halothane and enflurane are fluorocarbons that melt plastic and are excellent dry-

cleaning fluids, as well as potent anesthetics. Despite this, used carefully in the correct dosage, they are very safe, but the patient needs to be monitored closely.

What specific parameters need to be monitored? The anesthesiologist measures blood pressure and heart rate at least every five minutes in the most minor operations, because there is no such thing as a minor anesthetic. Changes in blood pressure and heart rate with upper and lower limits for each and maximum allowable rates of change of each could be monitored by computer.

Sometimes people with clogged-up arteries supplying the heart muscle need anesthetics. Over 60,000 of these persons had operations on the clogged-up vessels in 1977 (coronary bypass grafting). Many more of them have operations for other procedures, such as hernias and hysterectomies, and the anesthesiologist must not stress the heart during these operations. Because the oxygen delivered to the heart is restricted by the clogged vessels, these patients cannot tolerate anything that demands increased work and oxygen consumption.

Fortunately, a good indicator of the heart's oxygen consumption is the product of heart rate and blood pressure. Also, the electrocardiograph can indicate when the heart is being stressed too much. Both of these parameters could be calculated and monitored by the computer.

These are simple examples. There are many others, some simple, some complex. The computer could also monitor, record and process body temperatures and signals from the brain, the lungs and the kidneys, all of which are presently monitored by the anesthesiologist. Table 1 lists some of the parameters a computer could help monitor or calculate for the anesthesiologist.

I am excited about microprocessors, and I believe that in the near future we will see many of them being applied in operating rooms across the country. I also believe that I have only scratched the surface of a vast ocean of applications for microcomputers in the biological sciences. The future is very sanguine for these machines, and all that is needed is someone to begin testing and developing them in the operating room and the biological laboratories. Until this is done, their ultimate versatility and usefulness remains untested. ■

✓ Reader Service—see page 179

✓ Reader Service—see page 179

Telpar Thermal Printer

The Apple II prints too, and the Telpar Thermal Printer does it.

C. R. (Chuck) Carpenter
2228 Montclair Pl.
Carrollton TX 75006

The Apple II system with the Telpar PS-40 printer.

In a previous article ("SHHH—People Are Sleeping," *Kilobaud MICROCOMPUTING*, January 1979, p. 59), I described how you could connect a Telpar thermal printer to your KIM-1. In this article, Apple II becomes the host computer for my Telpar PS-40 printer. Because I described in detail the power-supply and hookup requirements in the January article, I will only include items that are unique for the Apple II in this article.

As you know, Apple II is a compact, self-contained unit with the keyboard, the power supply and the entire microcomputing system included in one package. But, at this time, there are few peripheral boards to plug into the existing connectors. As an interim measure, Apple has provided a machine-language routine (Program A) to slow down the data stream rate (to 110 or 300 baud) and direct it to the annunciator output port, ANO (the game paddle connector). Fig. 1 shows the general block diagram of the system, and Fig. 2 shows the connections made to the printer to interface it with the Apple II.

Hookup is Simple

An output adapter circuit is required to connect the output port ANO to your printer. The circuit and a pictorial of the wiring are shown in Fig. 3. I used a 16-pin header to hook up the parts. This way you can plug the printer adapter directly into the game paddle connector as needed. (You can solder the game paddle connector to the 16-pin IC plug, too.)

Making It Run

To use the printing routine, first key in Program A. (Make a copy on tape before you continue just in case.) Depending on your choice of language—machine, Apple integer, or AppleSoft F.P.—you can call the routine as needed. The printout in Program A was made using the Apple II monitor commands. The listing and the hex dump are both possible from the Apple II keyboard.

First type 36BG, then RETURN. If the program is

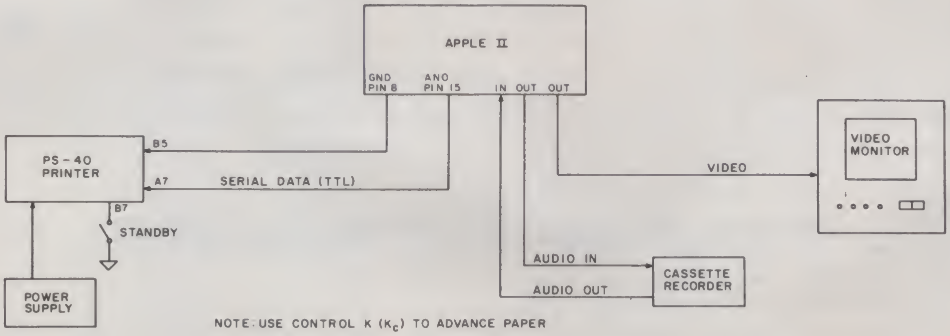

Fig. 1. System block diagram (serial print—TTL input).

Start Print	Stop Print
* 36BG	* 37EG
> CALL 875	> CALL 894
] SP=USR(875)	] EP=USR(894)

Note: To activate, type in and hit RETURN

* = From Apple Monitor

> = From Integer BASIC

] = From Apple Soft BASIC

Print routine.

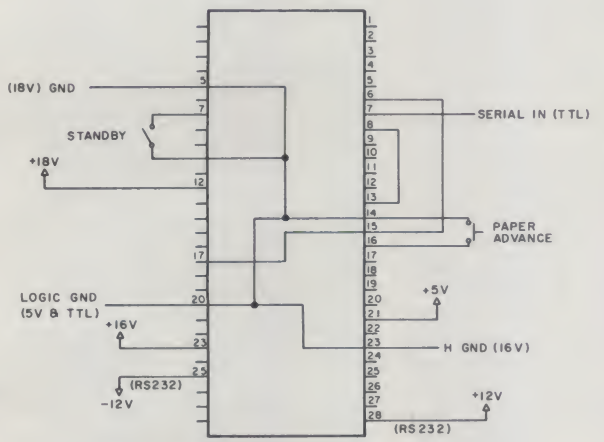

Fig. 2. Input and power connections.

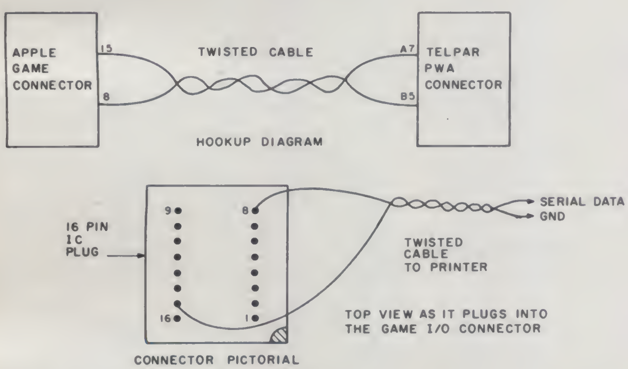

Fig. 3. Serial data adapter schematic and wiring pictorial.

working, you will see the response slow down on the TV monitor. The printer will respond with a return at the same time. Type 37EG and RETURN to get out of the print routine.

If you use Apple integer BASIC, the routine is activated by CALL 875—the decimal value of $36B. Use CALL 894 to stop printing. The same technique is used with AppleSoft F.P. BASIC, except you use X = USR(875) to call the program and X = USR(894) to stop. Change the printing speed from 110 to 300 baud by changing the data at address $3B4 to $4D.

A Further Note

Apple has a number of I/O boards coming; by the time you read this, some of them will be available. However, the cost of connecting a printer using this simple interface is so attractive, I don't think I'll rush out and get a board when they are available. The system works fine and I have had much enjoyment printing and using the programs I have developed with my Apple II and AppleSoft BASIC.

```
036B-   A5 36      LDA   $36
036D-   8D C6 03   STA   $03C6
0370-   A5 37      LDA   $37
0372-   8D C7 03   STA   $03C7
0375-   A9 89      LDA   #$89
0377-   85 36      STA   $36
0379-   A9 03      LDA   #$03
037B-   85 37      STA   $37
037D-   60         RTS
037E-   AD C6 03   LDA   $03C6
0381-   85 36      STA   $36
0383-   AD C7 03   LDA   $03C7
0386-   85 37      STA   $37
0388-   60         RTS
0389-   84 35      STY   $35
038B-   48         PHA
038C-   20 A5 03   JSR   $03A5
038F-   68         PLA
0390-   C9 8D      CMP   #$8D
0392-   D0 0C      BNE   $03A0
0394-   A9 8A      LDA   #$8A
0396-   20 A5 03   JSR   $03A5
0399-   A9 58      LDA   #$58
039B-   20 A8 FC   JSR   $FCA8
039E-   A9 8D      LDA   #$8D
03A0-   A4 35      LDY   $35
03A2-   4C F0 FD   JMP   $FDF0
03A5-   A0 0B      LDY   #$0B
03A7-   18         CLC
03A8-   48         PHA
03A9-   B0 05      BCS   $03B0
03AB-   AD 58 C0   LDA   $C058
03AE-   90 03      BCC   $03B3
03B0-   AD 59 C0   LDA   $C059
03B3-   A9 D3      LDA   #$D3
03B5-   48         PHA
03B6-   A9 20      LDA   #$20
03B8-   4A         LSR
03B9-   90 FD      BCC   $03B8
03BB-   68         PLA
03BC-   E9 01      SBC   #$01
03BE-   D0 F5      BNE   $03B5
03C0-   68         PLA
03C1-   6A         ROR
03C2-   88         DEY
03C3-   D0 E3      BNE   $03A8
03C5-   60         RTS
03C6-   F0 FD      BEQ   $03C5

*36B.3C7

036B- A5 36 8D C6 03
0370- A5 37 8D C7 03 A9 89 85
0378- 36 A9 03 85 37 60 AD C6
0380- 03 85 36 AD C7 03 85 37
0388- 60 84 35 48 20 A5 03 68
0390- C9 8D D0 0C A9 8A 20 A5
0398- 03 A9 58 20 A8 FC A9 8D
03A0- A4 35 4C F0 FD A0 0B 18
03A8- 48 B0 05 AD 58 C0 90 03
03B0- AD 59 C0 A9 D3 48 A9 20
03B8- 4A 90 FD 68 E9 01 D0 F5
03C0- 68 6A 88 D0 E3 60 F0 FD
*
```

Program A. Machine-language listing and hex dump of the print-control routine.

By the way, printing is not the only use for the routine included with this article. It can be used also to slow the screen speed down. This way you can read a listing or whatever while the output is slowly scrolling. ■

Apple Computers, Inc.
10260 Bandley Dr.
Cupertino CA 95014

Telpar, Inc.
4132A Billy Mitchell Rd.
PO Box 796
Addison TX 75001

BOOKS

(from page 14)

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William Colsher
Lisle IL

Periodical Guide for Computerists
E. Berg Publications
Aloha OR

My first reaction upon reading the flier for *Periodical Guide* was, "Why didn't someone think of this before?" As the title suggests, it is a specialized equivalent to the *Reader's Guide to Periodical Literature*—each volume indexes a year's worth of 25 magazines. Sixteen of them are dedicated to small computers, while the rest are general-interest electronics magazines that frequently feature microcomputer-related articles.

Besides articles, the book indexes editorials, letters, book reviews and record reviews. Updates and bug reports for articles are also listed.

Compilation of the *Periodical Guide* was obviously a tedious job. The effort was worthwhile, though, if my experience with it means anything; I refer to it constantly. It points me to information I might otherwise miss because I don't subscribe to all 25 magazines.

Moreover, it relieves me of having to rely on my (biological) memory when I want to find an article from a back issue that I do happen to have. If I wanted to learn more about the Intercept IM6100, for example, I would simply look up "Microcomputers, IM6100" and find three articles listed under it. Or, if I couldn't remember where I saw that article "Digital Foam—The Sexiest Peripheral," I would look it up under "Humor" and see that it ran in the July issue of *ROM*, beginning on page 93.

Another useful feature of the article index is that it is easy to see which magazines dominate which categories. We might notice, unsurprisingly, that most of the entries under "Amateur Radio" are from *73 Magazine*, for example. The magazines' addresses are listed for the benefit of those who wish to write for information on obtaining subscriptions or back issues.

There is also an author index, which could serve as a rudimentary "talent locator" for those who are searching for an expert in some area of microcomputer technology.

Although at $5 it is not inexpensive for a 72-page book, I intend to buy future volumes. My 1977 volume is easy to read and has a sturdy cover. A publication of this type would be a good investment for any serious hobbyist or professional.

David Price
Midlothian VA

Heathkit's BASIC Programming Course, $30
Heath Company
Benton Harbor MI

Most of the BASIC programming books on the market right now are recycled college texts. But what about us, the amateur computerists? How about a home-study course geared to our concerns? Now we have it—the Heathkit BASIC Programming Course, and it's a winner.

Don't let the Heathkit label fool you; the course is equally applicable to any micro-owner. Although there is no such thing as a text or course that can guarantee to make you a proficient programmer, this course comes as close as any I've seen to laying down a solid foundation.

Part I, the first 229 pages, covers the building blocks, or the tools of the trade: PRINT, decisions, numeric data, functions, loops, lists and arrays, strings and tricks of the trade. The first complete program in Segment 4 calculates the value or height of a stack of money given the denomination of the bills and either of the first two variables. It is a painless, jargonless introduction to the definition, design and implementation of a program.

The programmed-instruction format presents 148 byte-sized frames of information, each about one paragraph or more in length. At the end of each segment, there are enough questions to test yourself on each point covered.

The first program is referred to as "Building a Doghouse." The viewpoint taken throughout the course is that the parts of BASIC are tools with which you can build a doghouse, or a monument, depending entirely on your own skill or patience. I found this point of view appealing as it expresses the idea that programming is a craft; it is neither a disciplined science nor an intuitive art, but a combination of both.

I estimate that a thorough coverage of the first part would take 20 to 40 hours.

Part II, the next 134 pages, is concerned with building monuments. The first piece of construction is a program that adds, subtracts, multiplies or divides one or two decimal, hexadecimal, octal or split octal numbers in any base. This is where the creative aspects of computing begin.

The major problem is broken down into small parts. Alternative solutions are suggested. Tackle each small problem and, if your way doesn't work, then look up Heath's answer. The emphasis here is on arriving at a solution. How you do it—your way or Heath's way—doesn't really matter . . . just so that it works. I found this part of the course really exciting.

The second project is an authentic simulation of blackjack. There are 29 major decision points in the construction where you can do it your way, Heath's way or a combination of both. I have never before come across such an exhaustive and precise delineation of the major and minor considerations that go into the formulation of a particular program.

In this case, there are 87 creative pages. You could spend 20 hours on Part II, but I spent about 60 hours and expect to return to it many more times. If you insist on doing it all your way, then you can also expect to spend weeks on this part alone, although you'd probably be a better programmer for it.

The two main appendices contain 61 pages on number systems, lifted from Heath's microprocessor course, and a 105-page user's manual on Benton Harbor BASIC and Extended BASIC. I believe that both appendices are unnecessary duplications: The number systems information is readily available from many other sources; the user's manual is an exact duplication of what I received with my H8, although it would be of interest to someone who hasn't bought his own micro yet and is still wondering what BASIC is.

A 74-page workbook contains problems for each learning segment with exercises, experiments, hints for solutions and many complete programs. I'd like to see a periodic issue of this sort of workbook. With some ads of new products and editorials, it would be my ideal of a computer magazine.

The major fault of this course is a lack of attention to print layout and flowcharting. I've found both to be invaluable in defining the sequence of program design. Because this course is geared specifically to the amateur computerist, it emphasizes interaction between the programmer and his machine, which could form sloppy habits. It is often the case that 15 minutes with pencil, paper and eraser can save hours of frustration debugging on the console.

The Benton Harbor bias also shows in the lack of any study of deluxe features of BASIC such as PRINT USING and MATRIX functions, though *Some Common BASIC Programs* by Poole and Borchers (Osborne & Associates, Inc., publishers) shows you how to achieve many deluxe features using the simpler statements.

By the way, this collection of software is an excellent workbook for further study. Take each program description as a problem, see if you can put together a program to do the job and then see how Poole and Borchers did it. After working on Heath's course, you begin to realize that there are all sorts of ways to put together a program, one of which could be yours.

Evidently, Heath is looking for other topics for its programmed-instruction department. You are asked to fill out a questionnaire and send it in along with your final exam. Would you mind indicating an interest in a home-study course on carpentry? Then, as soon as Heath comes out with this course, I can build a desk to hold all my equipment . . . maybe even a wall rack for all my cassette tapes.

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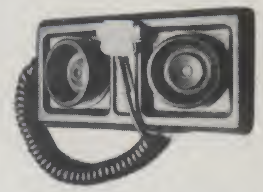

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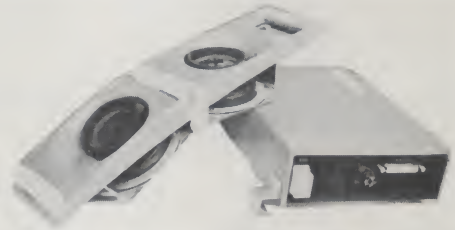

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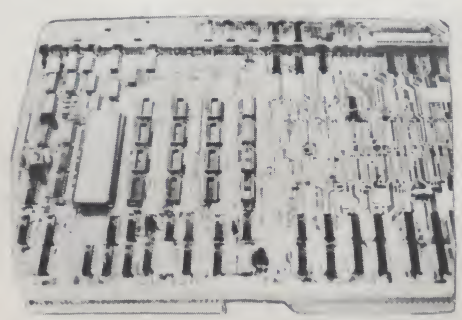

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Reader Service—see page 179

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TRS-80 Owners! Tired of endlessly thumbing through your Level II manual? Send $1 and SASE and receive a complete (and I *do* mean complete) TRS-80 Level II Manual Index. You won't believe how much time this will save you. *Everything* is listed alphabetically. Send $1 to Dave Rose, 196 Governors Drive, Forest Park GA 30050.

Micro Users Tax Booklet 78 shows how to slash taxes with deductions for micro. Many illustrations and examples. $4.99. MicroTax 78 completes 1040, schds A, B, C, D and others in minutes. Eliminates errors, missed deductions, and saves time. 16K TRS-80 Level II. $9.99. Save $2; order both for $12.98. Check or MO: George Clisham, PO Box 1172, Duxbury MA 02332.

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TRS-80 Owners. I am interested in surveying TRS-80 users. Write: Professor Bill Parks, Chase-203, State University College, 1300 Elmwood Ave., Buffalo NY 14222.

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PET Owners: Send for FREE catalog of PET software. CMS, 5115 Menefee Dr., Dallas TX 75227.

Smoke Signal Broadcasting & SWTP owners: Software now available for Chieftain I & II microcomputer systems & SWTP 5" disk systems. Random accessing software: A/R Inven, $370; A/P, $270; P/R, $290; G/L, $290; F/A Inven system, $200. Application manuals are $20 each if purchased separately. Steve Chavez, 2920 Carlisle N.E., Albuquerque NM 87110.

For Sale: TTY-43, 3 months old, KRS/RS-232 absolutely perfect shape, $895 plus shipping. Or, trade & cash for Diablo Hytape II 1620. (914) 963-7963 evenings. Jed Arkin, PO Box 116, Yonkers NY 10704.

Cromemco Z2-D single floppy-disk computer with 48K memory, bytesaver board & TuArt Kit, connected with Lear-Siegler ADM3A terminal—all for $4000. Write or call: Mark Cohen, 729 Southmont Ave., South Wmspt. PA 17701. (717) 323-1070.

North Star Horizon "club my mail!" Share thoughts & ideas on hardware and software. No fees—no dues. Write: Ron Magazzu, 13 Macfarlan, Hawthorne NJ 07506.

MYCHESS—Z-80 assembly-language program takes appx. 5 secs. for 2-ply, full-width search w/advanced swap-off evaluator. Has large, easily expandable opening book. Checkmated Microchess II in 24 moves w/black; 21 moves w/white. Runs on CDOS or CP/M in 20K. Specify 5" or 8" disk. $20. David Kittinger, 2431 Lyvona Lane, Anchorage AK 99502.

TRS-80 "Nude Girl" wall calendar (8 1/2 × 44 inch.) created on printer with BASIC. Nicely done! Tape, $10; printout or list, $6. Adapt to other computers. TCS, PO Box 10281, Norfolk VA 23513.

Xitan (TDL) software 25-30% off. Never used. Software package A3 for North Star disk (list $249), $185. CP/M disk BASIC (list $159), $120. Complete software package A3 Plus for CP/M disk (list $409), $305. Software package A3 cassettes (with Super BASIC or VDB BASIC) (list $219), $160. Interface One (list $40), $30. All in original containers with manuals. All new. Cash or COD. Write: Bob Rockinson, 211 Sixth Ave., Brownsville PA 15417. (412) 785-6071.

CASSETTES, quality G.E., leaderless. 10 min., shipped prepaid via UPS. 10 for $6.00; for $27.50; 100 for $50; Rudolph Nelson, W1HWY, PO Box 421, Merrimack NH 03054.

Micropolis software special: Investment analysis package, $30; Home/family package, $30; Assembly language prog. course for beginners, $30; Accts. receivable program, $95. This is in Mod II drive only. Order now. Phil Bell, 813 MacArthur Dr., Urbana IL 61801.

Imsai PCS 8030 with MIO board and 16K memory, kit $1650. Also Imsai 8080 with 4K RAM memory, $700. W. R. Deisenroth, RD 2 Box 621, Jersey Shore PA 17740. Phone (717) 322-7119.

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TRS-80 Profit/Loss operating statement. Mo. printout of 22 or more expense items (your choice) w/running year-to-date totals. Very professional print format. Prompted. Any business can run. Disk or cass. Also other programs. Designed for printing companies. George Croft, 5019 W. Lovers Ln., Dallas TX 75209.

Commodity, Stock, Option-buyers & sellers. Many trading and invest. programs for the TRS-80, Apple, PET for sale or loan. SASE for details and list #1-200. Irv, 4122 S.W. 65 Avenue, Davie FL 33314.

For Sale: Several Digital Group Real World Interface Systems. Interfaces to any 8-bit machine with parallel I/O ports. Has plugins for ac & dc controllers, CPU interfacing, A/D & D/A converters, temperature and current probes and prototyping boards for custom circuits. Write: A. K. Neel, 400 S. Lipan #2, Denver CO 80223.

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"Programs of the Month" club for TRS-80, PET, Apple. Receive 100's of programs free or at reduced rates. Details & list #04 for SASE. Barreiro, 1335 S.W. 91 Ave., Miami FL 33174.

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OSI Software; For use with Challenger II & III series: Letterwriter I (w/printer) consists of eight programs to suit your letter writing needs; Includes mini-wordprocessing, mailing label, envelope and letter dup. programs —$29.95. Extra OSI power, Info regarding a complete word-processing system for under $1000—$1.00. P. A. Reynolds, 2514 12th St., Galena Park TX 77547.

"Guide to TRS-80 Information," 2nd Ed. Special handbook/companion for TRS-80 user/owners. Over 400 interesting items! Satisfaction Guaranteed! If not satisfied, return in 15 days for FULL refund! One: $2.80 + $.50 P&H. 2 to 9: $2.75 @. 10 to 50: $1.90 @. CK or MO with name, address and zip to: F. E. Huebner, Box 37206, Oak Park MI 48237.

TRS-80 Yellow Page. A free catalog of software & hardware. For fast delivery, TRS-80 owners send 2 SASE envelopes and $1. Vendors send $20 & full prod. descrip. to share printing costs. Features business software & word processing. Write to: 96 Dothan St., Arlington MA 02174.

PET: I need a card reader/punch to plug into my 8K PET. It has to WORK and not cost all outdoors. Write B. Klinger, Box 423, Rye NH 03870.

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TRS-80 Level II, 16K Disassembler program, Zilog mnemonics, written in BASIC, 150 lines. Listing, $2. Cassette, $4. John B. Sweeney, 1 Victor Dr., Albany NY 12203.

TRS-80 Cheap Printer—Super cheap, absurdly simple interface for Model 15 Teletype or similar. Instructions, $2. Instructions and software on tape, $5. Complete interface, just $50. Runs in Level I or II or with EDTASM. Also will echo screen or respond to LLIST and LPRINT or will Level I screen print. I bought my 15 for $25. N. Gregory, 107 Fairdale, Lex. KY 40505.

For Sale: Technico TMS-9900 CPU, 16 bit, with 2K RAM, 2K ROM (monitor & assembler), 2K EPROM & programmer. Documentation, manuals & cables. Factory tested, never used: $275. S. J. Huber, 318 Steven Ct., Benicia CA 94510. (707) 745-8089.

Heath Microcomputer Course (EE-3401) and Microcomputer Trainer (ET-3400); wired, complete, new condition. $225 postpaid. Don Ketchum, 313 Van Ness, Upland CA 91786.

Educational software and other useful programs on cassette for TRS-80, Level II. Descriptions from Dr. S. Harter, Box 17222, Tampa FL 33682.

TRS-80 Software: Business programs written in 16K Level II. Available for cassette or disk files. Send for list & prices. L. Owens, Rt. 6, Box 336A, Thomasville GA 31792.

CORRECTIONS

The last page of "SHHH . . . People are Sleeping" (p. 62) by Charles R. Carpenter (January 1979) indicates that the Telpar PS-40 printer costs $4. Sounds like a great deal; unfortunately, a couple of zeros are missing. The price should be $400.

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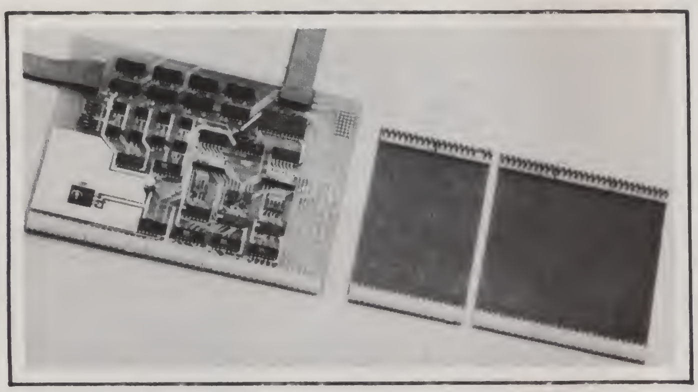

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This is the most versatile control interface card yet to be offered to the micro-computer owner; certainly at this price! The interface plugs onto your SWTPC or SS-50 bus and needs no external power or interfacing. There are 16 DIP switches on the board which the user sets to any address he chooses—whether there is already memory there or not. The board is fully buffered. The interface has 8 fast reed relays that latch open for 0, or closed for 1 in the bit pattern of the byte that the computer system stored at the address set on the switches. The Control Interface also has 8 opto-isolators which will allow real-world sources to communicate with your computer. The outside inputs will be read by the computer system as a byte stored at the address set on the switches; just as if the byte came from memory. As a debugging tool the Control Interface may be used to monitor the state of any byte of system memory. The interface may also be used to input keyboard data or to input a response from the device It is controlling (Robot users take note).

The opto-isolators may be software-disabled for use of the board over a byte of memory. The relays may be manually disabled to allow the Control Interface's TTL outputs to become a Parallel Interface. With the Control Interface it's easy for anyone's computer to control the world, or at least Burglar Alarms, Music, Robotics, Solar Energy Systems, etc. The uses are virtually limitless! Because of the board's smart hardware the software is simple. In Assembly Language just read and write to the interface's address. In Basic or other high-level languages just use the PEEK and POKE instructions. No messy PIA software to deal with.

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The Control Interface is $98 as a kit or $125 assembled and tested

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switches

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AMP hood........$1.50
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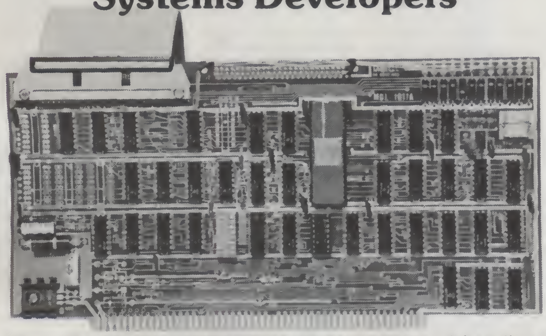

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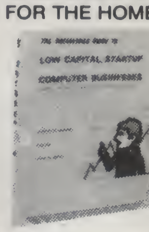

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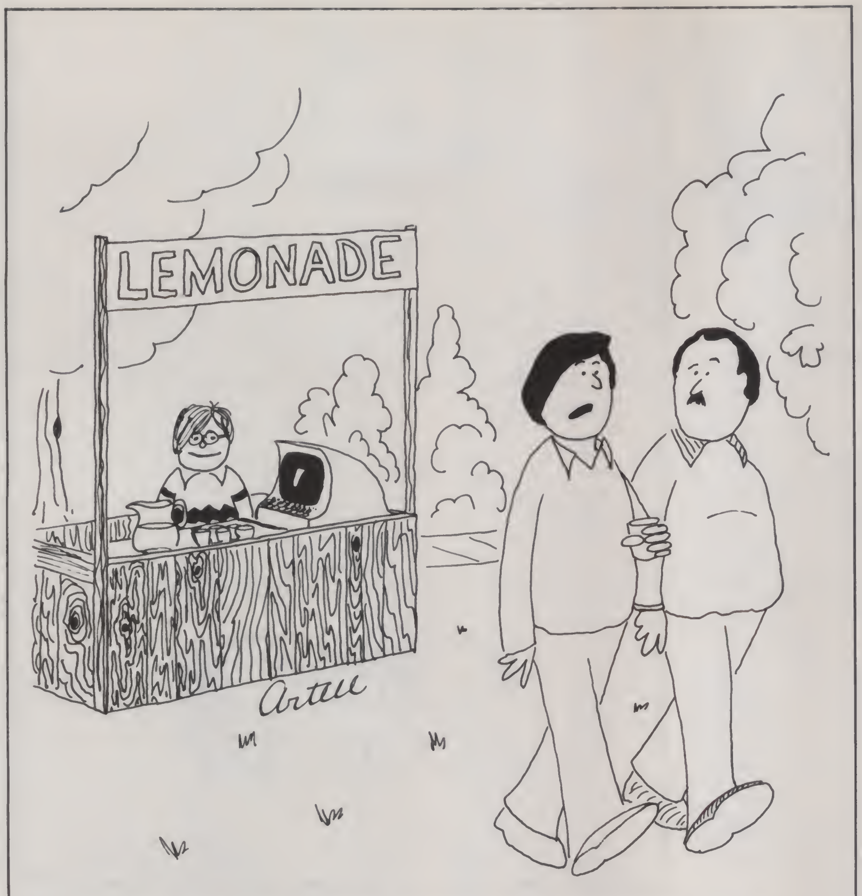

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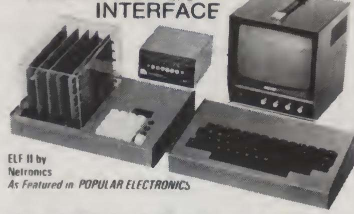

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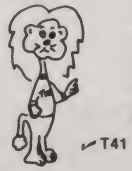

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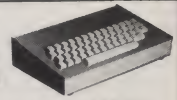

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CT7001	5.80
CT7002	8.95
CT7010	8.95
CT7015	7.25
MM5375AA/N	3.90
MM5375AB/N	4.90
7205	16.50
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7208	15.95
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DS0028CN	3.75
DS0056CN	3.75
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MICROPROCESSOR	
6800	17.50
6802	24.95
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8065	27.00
Z80	29.95

8212	2.90
8214	8.00
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8224	2.90
8228	5.35
8251	8.50
8253	10.00
8255	9.25
8257	19.50
8259	19.50
CDP1802CD	19.95
CDP1802D	25.00
CDP1861	12.95
6820	9.95
6850	12.95
6502	12.50

IC SOCKETS

Solder Tin		Low Profile	
PIN	1 UP	PIN	1UP
8	.15	22	.30
14	.18	24	.35
18	.20	28	.42
18	.27	36	.58
20	29	40	.57

3 level wire wrap gold
14 pin .25 16 pin 27
2 level 14 pin ww 20

WIRE WRAP LEVEL 3

PIN		PIN	
14	.25	24	86
18	.27	28	1.00
18	.57	40	1.23

UART/FIFO	
AY5-1013	5.50
AY5-1014	7.50
3341	6.95
PROM	
1702A	3.95
N82S23	2.95
N82S123	3.50
N82S126	3.75
N82S129	3.75
N82S131	3.75
N82S136	8.75
N82S137	8.75
2708	12.50
DM8577	2.90
8223	2.90
2716T1	22.50
2718 Intel	48.00
CRYSTALS	
1 MHz	4.50
2 MHz	4.50
4 MHz	4.25
5 MHz	4.25
10 MHz	4.25
18 MHz	3.90
20 MHz	3.90
32 MHz	3.90
32768 MHz	4.00
1.8432 MHz	4.50
3.5795 MHz	1.20
2.0100 MHz	1.95
2.097152 MHz	4.50
2.4578 MHz	4.50
3.2768 MHz	4.50
5.0688 MHz	4.50
5.185 MHz	4.50
5.7143 MHz	4.50
6.5536 MHz	4.50
14.31618 MHz	4.25
18 432 MHz	4.50
22.1184 MHz	4.50
CONNECTORS	
44 pin edge	2.00
100 pin edge	4.50
100 pin edga WW	4.50
KEYBOARD ENCODERS	
AY5-2378	$12.50
AY5-3600	13.50
74C922	5.50
74C923	5.50
HD0165-5	8.95

IC Test Clips

	1	10
Red	.55	.47
Black	.55	47

Keyer 8043 14.50
comp. w/spec./sock.

TRANSISTORS	
2N1893	.40
2N2222A	.18
2N2369	.30
2N2904A	20
2N2907A	25
2N3053	.40
2N3638	.25
2N3643	.25
2N3904	.16
2N3906	.18
2N3055	69
2N4400	.25
2N4401	.75
2N4402	.20
TIP31	60
TIP33A	1.00

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MA1002A, C or E .50"	**8.95**
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Special transformer and six switches when purchased w/module	**2.95**
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RESISTORS ¼ watt 5%
10 per type .03 1000 per type .012
25 per type .025 350 piece pack
100 per type .015 5 per type 6.75

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56 key ASCII keyboard kit	$62.50
Fully assembled	72.50
53 kay ASCII keyboard kit	55.00
Fully assembled 85.00 Enclosure	14 95
LEDS	
Red T018	.15
Green, Dranga, Yallow T018	.20
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Clipiite LED Mounting Clips	8/$1.25

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Complete line of braadboard test equip
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Batt. oper. General purpose or medical 32°–230°F. Disposable proba cover ±.2° accuracy. Comp. Assy. in compact case

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12.6V CT 600 ma	3.75
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12V CT 250 ma wall plug	3.50
24V CT 400 ma	3.95
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DL747/750	CA/CC	600	1.95
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FND500/507	CC/CA	.500	1.35
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8100		40V	3.00
6100		50V	3.00
7700		50V	2.50
8000		55V	2.50
9400		85V	3.00
10000		20V	2.50
12000		30V	3.50
35000		25V	5.00
55000		25V	5.00
82000		15V	8.00
160000		10V	6.00

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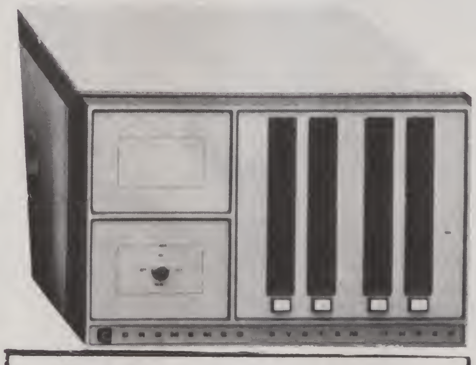

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TU-ART Digital Interface, Kit List $195 (order as 02-3440-0) 165

Assembled/Tested, $295 (02-4440-0) . . . 250

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Multiple User BASIC Now Available!

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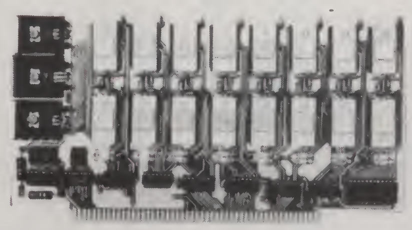
16K EPROM CARD-S 100 BUSS



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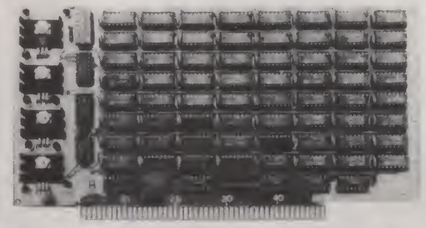
250 NS SALE!



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Use 21L02 450 NS RAMS!

Thousands of computer systems rely on this rugged, work horse, RAM board. Designed for error-free, NO HASSLE, systems use.

KIT FEATURES:

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2. All sockets included.
3. Fully buffered on all address and data lines.
4. Phantom is jumper selectable to pin 67.
5. FOUR 7805 regulators are provided on card.

Blank PC Board w/Documentation **$29.95**
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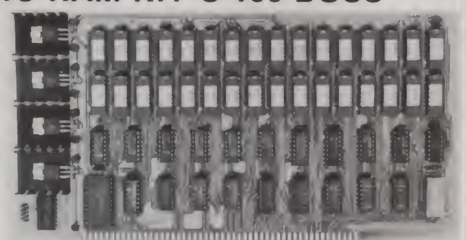
$295 KIT



FULLY STATIC, AT DYNAMIC PRICES

WHY THE 2114 RAM CHIP?

We feel the 2114 will be the next industry standard RAM chip (like the 2102 was) This means price. availability, and quality will all be good! Next, the 2114 is FULLY STATIC! We feel this is the **ONLY** way to go on the S-100 Buss! We've all heard the HORROR stories about some Dynamic Ram Boards having trouble with DMA and FLOPPY DISC DRIVES. Who needs these kinds of problems? And finally, even among other 4K Static RAM's the 2114 stands out! Not all 4K static Rams are created equal! Some of the other 4K's have **clocked** chip enable lines and various timing windows **just as critical** as Dynamic RAM's. Some of our competitor's 16K boards use these "tricky" devices. But not us! The 2114 is the ONLY logical choice for a trouble-free, straightforward design.

KIT FEATURES:

1 Addressable as four separate 4K Blocks.
2. ON BOARD BANK SELECT circuitry. (Cromemco Standard!) Allows up to 512K on line!
3. Uses 2114 (450NS) 4K Static Rams.
4. ON BOARD SELECTABLE WAIT STATES.
5. Double sided PC Board, with solder mask and silk screened layout. Gold plated contact fingers.
6. All address and data lines fully buffered.
7 Kit includes ALL parts and sockets.
8. PHANTOM is jumpered to PIN 67.
9. LOW POWER: under 2 amps TYPICAL from the +8 Volt Buss.
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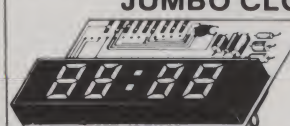

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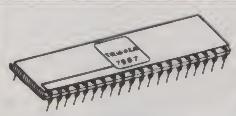

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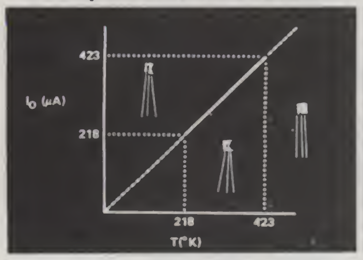

Two terminal I.C. Temperature Transducer
ANALOG DEVICES AD590J is a two terminal device producing an output current proportional to absolute temperature. Laser triming produces ± 9°C maximum error without external calibration. Calibration can reduce maximum error to only ± 2°C over -55° to +150°C range. Sensitivity is 1uA/°K. Use with +4 to +30V supply as input to digital meter in thermometer applications. Excellent for remote applications due to the very high impedance. Comes in TO-52 metal can.

AD590J.....................................$3.49
Specs and Application sheets.................... .80

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MC14411P Baud Rate generator...............$11.98
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TRI-TEK has become a major source for the 7800 and 7900 series 3-terminal regulators in TO-220 package. These PRIME parts are factory first quality!! At these prices, you can't afford re-tested fall outs. Available in the following voltages. Last 2 digits indicate voltage.

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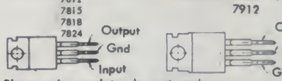

Please order regulators by part numbers.
78XX (pos) 95¢, 5/$4.50, 79XX (neg) $1.10, 5/$5

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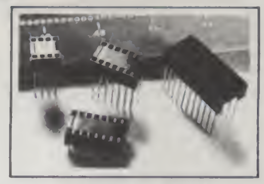
Texas Instruments

Low Profile DIP Solder Tail (Tin). End/side stackable on .1" centers!

		1-24	25-99	100-999	1000-Up
SKT-0802	8 pin	.15	.14	.12	.115
SKT-1402	14 pin	.18	.18	.15	.135
SKT-1602	16 pin	.20	.19	.17	.150
SKT-1802	18 pin	.26	.25	.24	.185
SKT-2002	20 pin	.32	.31	.29	.210
SKT-2202	22 pin	.35	.34	.33	.235
SKT-2402	24 pin	.35	.34	.33	.250
SKT-2802	28 pin	.43	.42	.41	.300
SKT-4002	40 pin	.59	.57	.55	.430



3 LEVEL WIRE WRAP GOLD
Sockets include features most desired by the electronics industry - gold over nickel plating, closed entry - removable covers and replaceable pins.

		1-9	10-24	25-99	100-999
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SKT-1400	14 pin	.34	.33	.32	.30
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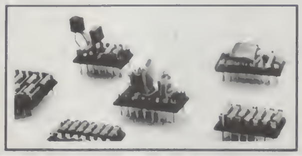
SKT-1800	18 pin	.68	.67	.57	.52
SKT-2000	20 pin	.90	.86	.74	.67
SKT-2200	22 pin	.93	.90	.80	.70
SKT-2400	24 pin	.95	.89	.78	.72
SKT-2800	28 pin	1.20	1.04	.99	.92
SKT-4000	40 pin	1.53	1.45	1.35	1.19



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Use for mounting diodes, resistors, jumpers, etc.
Gold plated parts for ease of soldering and reliability.

	PLUGS			COVERS	
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78P05SC 5V 10A TO-3 Reg..................$12.95
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4804 1KX4 Static RAM.............$8.95, 8/ $60.00

MICRO PROCESSOR COMPATIBLE A/D CONVERTERS
National Semi ADC3511 and 3711 are CMOS monolithic A/D converters. Pluse modulation analog-to-digital conversion is used and requires no external precision components except the reference voltage.

Single 5 volt operation. Operation with an isolated supply allows conversion of either polarity. Sign is automatically determined and indicated on the sign pin.

The ADC3511 and 3711 have been designed to provide address BCD data and are intended for use with micro processors and other digital systems. BCD digits are selected on demand via 2 Digit Select inputs. Digit Select inputs are latched. Start conversion input and conversion complete output are included on both types.

FEATURES
- .Single 5V Supply
- .ADC3511 3½ digits (0 to ± 1999 counts)
- .ADC3711 3 3/4 digits (0 to ± 3999 counts)
- .Addressed BCD Outputs
- .Easily interfaced to micro processor
- .TTL compatible

ADC-3511 (3-1/2 digit) $12.95
ADC-3711 (3-3/4 digit) $14.95
Spec for both parts.......................... .80

POWER OP AMP
250mA output current capability. Operates on as low as 3V. Input parameters are programmable for system optimizing. Electronic shut down allows output to float. Packaged in 8 pin mini-dip.
LM13080N.......................... $1.94
Specs and applications...... .60

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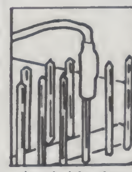

Jumper Kits for .025 Square Posts. All material for making jumpers for quick circuit changes and prototyping. Use for breadboarding, trouble shooting, field modifications. Fits standard IC socket wire/wrap posts. Excellent wiping action on gold plated box contacts. Kit contain 10 box contacts, heat shrinkable sleeving, and 5 feet of wire plus instruction sheet.
JCK-5101....(5 double jumpers)$2.75, 4 kits/$10.00

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6502 uProcessor..............................$10.95

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Switching regulator chip can convert from one voltage to another-either up or down!! Use this one to get positive or negative 12V from your +5V supply for those MOS parts. Starting with anywhere from +4.5V to +12V you can get from +30V down to -25V out. Adjustable output at up to 500mA. We are offering the chip plus a miniature inductor needed for the converter and spec sheet for only $9.50.
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- FULLY-ASSEMBLED AND COMPLETELY INTEGRATED SYSTEM that's ready-to-use
- ALL LSI IC'S ARE IN SOCKETS
- 28 DOUBLE-FUNCTION KEYPAD INCLUDING UP TO 24 "SPECIAL" FUNCTIONS
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- KIM-1* HARDWARE COMPATIBILITY
  The powerful 6502 8-Bit MICROPROCESSOR whose advanced architectural features have made it one of the largest selling "micros" on the market today.
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- 1K BYTES OF 2114 STATIC RAM onboard with sockets provided for immediate expansion to 4K bytes onboard, with total memory expansion to 65, 536 bytes.
- USER PROM/ROM: The system is equipped with 3 PROM/ROM expansion sockets for 2316/2332 ROMs or 2716 EPROMs
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- STANDARD INTERFACES INCLUDE:
  - —Audio Cassette Recorder Interface with Remote Control (Two modes: 135 Baud KIM-1* compatible, Hi-Speed 1500 Baud)
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- APPLICATION PORT: 15 Bi-directional TTL Lines for user applications with expansion capability for added lines
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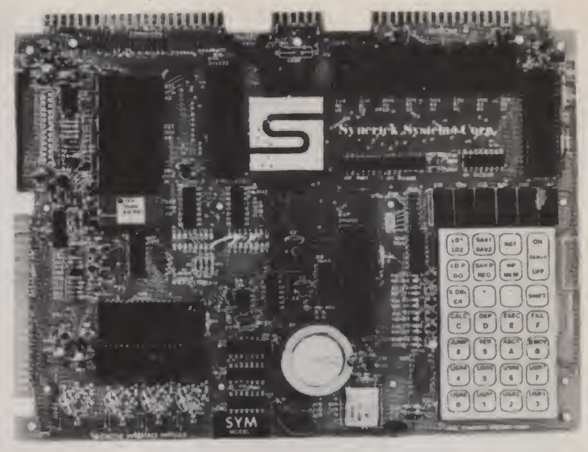
- AUDIBLE RESPONSE KEYPAD



Synertek has enhanced KIM-1* software as well as the hardware. T software has simplified the user interface. The basic SYM-1 system programmed in machine language. Monitor status is easily accessib and the monitor gives the keypad user the same full functional capab ty of the TTY user. The SYM-1 has everything the KIM-1* has to off plus so much more that we cannot begin to tell you here. So, if you wa to know more, the SYM-1 User Manual is available, separately.

SYM-1 Complete w/manuals	**$269.00**
SYM-1 User Manual Only	**7.00**
SYM-1 Expansion Kit	**75.00**

Expansion includes 3K of 2114 RAM chips and 1-6522 I/O chip.

SYM-1 Manuals: The well organized documentation package is co plete and easy-to-understand.

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These boards are set up for use with a regulated power supply such as the one below, but, provisions have been made so that you can add onboard regulators for use with an unregulated power supply. But, because of unreliability, we do not recommend the use of onboard regulators. All I.C.'s are socketed for ease of maintenance. *All boards carry full 90-day warranty.*

All products that we manufacture are designed to meet or exceed industrial standards. All components are first qualtiy and meet full manufacturer's specifications. All this and an extended burn-in is done to reduce the normal percentage of field failures by up to 75%. To you, this means the chance of inconvenience and lost time due to a failure is very rare; but, if it should happen, we guarantee a turn-around time of less than forty-eight hours for repair.

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This motherboard uses the KIM-4* bus structure. It provides eight (8) expansion board sockets with rigid card cage. Separate jacks for audio cassette, TTY and power supply are provided. Fully buffered bus.

VAK-1 Motherboard **$129.00**

VAK-2/4 16K STATIC RAM BOARD

This board using 2114 RAMs is configured in two (2) separately addressable 8K blocks with individual write-protect switches.

VAK-2 16K RAM Board with only 8K of RAM (½ populated)	**$239.00**
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VAK-4 Fully populated 16K RAM	**$379.00**

VAK-5 2708 EPROM PROGRAMMER

This board requires a +5 VDC and ±12 VDC, but has a DC to DC multiplyer so there is no need for an additional power supply. software is resident in on-board ROM, and has a zero-insertion sock

VAK-5 2708 EPROM Programmer **$269.00**

VAK-6 EPROM BOARD

This board will hold 8K of 2708 or 2758, or 16K of 2716 or 25 EPROMs. *EPROMs not included.*

VAK-6 EPROM Board **$129.00**

VAK-7 COMPLETE FLOPPY-DISK SYSTEM (Feb. '79)

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This board allows you to create your own interfaces to plug into motherboard. Etched circuitry is provided for regulators, address a data bus drivers; with a large area for either wire-wrapped or solder IC circuitry.

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*KIM is a product of MOS Technology

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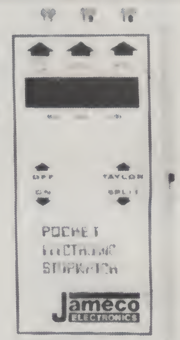
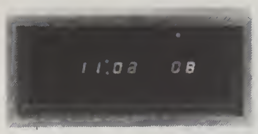


JE900

- ★ Use Intersil 7205 Chip
- ★ Plated thru double-sided P.C. Board
- ★ LED display (red)
- ★ Times to 59 min. 59.59 sec. with auto reset
- ★ Quartz crystal controlled
- ★ Three stopwatches in one: single event, split (cummulative) and taylor (sequential timing)
- ★ Uses 3 penlite batteries
- ★ Size: 4.5" x 2.15" x .90"



JE701

- ★ Bright .300 ht. common cathode display
- ★ Uses MM5314 clock chip
- ★ Switches for hours, minutes and hold functions
- ★ Hours easily viewable to 20 feet
- ★ Simulated walnut case
- ★ 115 VAC operation
- ★ 12 or 24 hour operation
- ★ Includes all components, case and wall transformer
- ★ Size: 6-3/4" x 3-1/8" x 1-3/4"

6-Digit Clock Kit

JE747

- ★ Four .630" ht. and two .300" ht. common anode displays
- ★ Uses MM5314 clock chip
- ★ Switches for hours, minutes and hold functions
- ★ Hours easily viewable to 30 feet
- ★ Simulated walnut case
- ★ 115 VAC operation
- ★ 12 or 24 hour operation
- ★ Includes all components, case and wall transformer
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Palo Alto	*Zack Electronics*
Pasadena	*Dow Radio Inc.*
Sacramento	*Heathkit Electronic Center*
Sacramento	*Zackit*
San Carlos	*J & H Outlet Store*
San Diego	*Radio Shack A.S.C. Mira Mesa*
San Fernando	*San Fernando Electronics*
San Francisco	*Zack Electronics*
San Jose	*United Radio & TV Supply*
San Luis Obispo	*Mid-State Electronic Supply*
Santa Ana	*Quality Electronics*
Santa Cruz	*Santa Cruz Electronics*
Santa Maria	*Caps Electronics*
Santa Monica	*Mission Control*
Suisun City	*Byte Shop*
Sunnyvale	*Sunnyvale Electronics*
Vallejo	*Zackit*
Walnut Creek	*MicroSun Computer Center*
COLORADO	
Aurora	*Com Co Electronics*
Durango	*The Computer Shop*
CONNECTICUT	
Bridgeport	*Bridgeport Computer*
FLORIDA	
Ft. Lauderdale	*Computers For You*
GEORGIA	
Atlanta	*Atlanta Computer Mart*
Columbus	*Radio Wholesale*
HAWAII	
Honolulu	*Integrated Circuit Supply*
IDAHO	
Idaho Falls	*Audiotronics*
ILLINOIS	
Evanston	*Tri-State Electronic Corp.*
Groveland	*Moyer Electronics*
Mount Prospect	*Tri-State Electronic Corp.*
ILLINOIS (Continued)	
Oak Park	*Spectronics Inc.*
Rockford	*Imperial Computer Systems*
Schaumburg	*Data Domain*
INDIANA	
East Chicago	*Acro Electronics Corp.*
IOWA	
Indianola	*Electronix Limited*
KANSAS	
Wichita	*Amateur Radio Equipment Company*
KENTUCKY	
Lexington	*Radio-Electronic Equipment Co.*
LOUISIANA	
Baton Rouge	*Pelican Electronics*
Houma	*Pelican Electronics*
Metarie	*Pelican Electronics*
MARYLAND	
Churchville	*Churchville Electronics*
Damascus	*Damascus CB*
La Vale	*J & M Electronics*
Rockville	*Computer Workshop*
Rockville	*Heathkit Electronic Center*
Towson	*Baynesville Electronics Inc.*
Towson	*Heathkit Electronic Center*
MASSACHUSETTS	
Pittsfield	*Pittsfield Radio Co. Inc.*
Waltham	*Computer Mart Inc.*
Worcester	*RM Electronics Inc.*
MICHIGAN	
Ann Arbor	*Wedemeyer Electronic Supply*
Clawson	*Radio Supply & Engineering*
Detroit	*Heathkit Electronic Center*
Flint	*Hobby Electronic Center*
Garden City	*Computer Center*
Lansing	*Fulton Radio Supply Co.*
Lansing	*Wedemeyer Electronic Supply*
Midland	*Computronix Corp.*
Mt. Clemens	*The Computer Store*
Niles	*Niles Radio Supply*
MINNESOTA	
Duluth	*Northwest Radio of Duluth*
Hopkins	*Heathkit Electronic Center*
St. Paul	*Heathkit Electronic Center*
MISSOURI	
El Dorado Springs	*Beckman Electronics*
MONTANA	
Billings	*Conley Radio Supply*
Bozeman	*Electronic Service & Dist.*
NEBRASKA	
Lincoln	*Altair Computer Center*
Lincoln	*Scott Electronic Supply Inc.*
Omaha	*Heathkit Electronic Center*
Omaha	*Omaha Computer Store*
NEVADA	
Las Vegas	*Century 23*
NEW JERSEY	
Bricktown	*Radio Shack Associate Store*
Cherry Hill	*The Computer Emporium*
Pompton Lake	*Computer Corner of New Jersey*
Ramsey	*Typetronic Computer Store*
NEW MEXICO	
Las Cruces	*Mannie's Electronic Supply*
NEW YORK	
Endwell	*Computer Tree Inc.*
Kingston	*Greylock Electronics*
New York	*Computer Mart of New York*
Troy	*Trojan Electronics*
Utica	*Am-Com Electronics*
NORTH CAROLINA	
Boone	*Alpha Digital Systems*
Durham	*Futureworld*
Greensboro	*Byte Shop*
Raleigh	*Byte Shop of Raleigh*
NORTH DAKOTA	
Fargo	*The Computer Company*
OHIO	
Bucyrus	*Mead Electronics*
Cincinnati	*Heathkit Electronic Center*
Columbus	*Heathkit Electronic Center*
Dayton	*Altair Computer Center*
Reynoldsburg	*Universal Amateur Radio*
OKLAHOMA	
Oklahoma City	*Bits, Bytes & Micros*
OREGON	
Albany	*Oregon Ham Sales*
Coos Bay	*Herrick Electronics*
Portland	*Portland Radio Supply*
Salem	*Computer Pathways*
PENNSYLAVANIA	
Hershey	*Microcomputer Systems Inc.*
Pittsburgh	*Heathkit Electronic Center*
York	*G.Y.C. Company*
RHODE ISLAND	
Cranston	*Jabbour Electronics City*
Pawtucket	*Jabbour Electronics City*
TENNESSEE	
Chattanooga	*William's Data Comp Div.*
TENNESSEE (Continued)	
Clarksville	*Masstronics*
Cookeville	*Wagnon's Sterao Center*
Knoxville	*Eastern Micro*
Nashville	*Electra Distributing Co.*
TEXAS	
Amarillo	*Computer Encounters Inc.*
Dallas	*CompuShop*
Houston	*Altair Computer Center*
Houston	*CompuShop*
Houston	*Interactive Computers*
San Antonio	*Sherman Electronics Supply Inc.*
UTAH	
Midvale	*Heathkit Electronic Center*
Provo	*Alpine Electronic Supply Co.*
VIRGINIA	
Alexandria	*Computer Hardware Store*
Alexandria	*Heathkit Electronic Center*
Charlottesville	*Lafayette Radio*
Falls Church	*Crossroad Electronics*
Hampton	*Lafayette Radio*
Norfolk	*Avec Electronics Corp.*
Richmond	*Avec Electronics Corp.*
Roanoke	*The Computer Place*
Virginia Beach	*Heathkit Electronic Center*
WASHINGTON	
Longview	*Progress Electronics*
Moses Lake	*Ron's Electronics*
Pasco	*Riverview Electronics*
Seattle	*Amateur Radio Supply*
Seattle	*C-Com*
Seattle	*Empire Electronics*
Spokane	*Personal Computers*
Tacoma	*C & G Electronics*
WEST VIRGINIA	
Morgantown	*Electro Distributing Co.*
Wheeling	*Lafayette Radio*
WISCONSIN	
West Allis	*Olson Electronics*
CANADA	
Alberta (Calgary)	*The Computer Shop*
Ontario (Willowdale)	*Home Computer Centre*
Quebec (Montreal)	*Wang's Microcenter*
ENGLAND	
Berkshire	*NewBear Computing Store*
GUAM	*Marianas Electronics*
PANAMA	
Panama City	*Sonitel, S.A.*
SINGAPORE	*Inter-trade (PTE) Ltd.*

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INTEGRATED CIRCUITS MICROPROCESSOR LED'S SOCKETS CAPACITORS DIODES TRANSISTORS RESISTORS POTENTIOMETERS

Reader Service—see page 179

Transistor Checker

— Completely Assembled —
— Battery Operated —

The ASI Transistor Checker is capable of checking a wide range of transistor types, either "in circuit" or out of circuit. To operate, simply plug the transistor to be checked into the front panel socket, or connect it with the alligator clip test leads provided. The unit safely and automatically identifies low, medium and high-power PNP and NPN transistors. Size: 3¾" x 6¼" x 2"
"C" cell battery not included.

Trans-Check $29.95 ea.

MICROPROCESSOR COMPONENTS

8080A/8080A SUPPORT OEVICES

8080A	CPU	$ 9 95
8212	8-Bit Input/Output	3.25
8214	Pnonty Interrupt Control	5 95
8216	Bi-Directional Bus Driver	3 49
8224	Clock Generator/Driver	3 95
8226	Bus Dnver	3 49
8228	System Controller/Bus Dnver	5 95
8238	System Controller	5 95
8251	Prog Comm. 1/0 (USART)	7 95
8253	Prog Interval Timer	14 95
8255	Prog. Periph. 1/0 (PPI)	9 95
8257	Prog. DMA Control	19 95
8259	Prog Interrupt Control	19 95

6800/6800 SUPPORT DEVICES

MC6800	MPU	$14 95
MC6802CP	MPU with Clock and Ram	24 95
MC6810API	128X8 Static Ram	5 95
MC6821	Periph Inter Adapt (MC6820)	7 49
MC6828	Pnonty Interrupt Controller	12.95
MC6830L8	1024X8 Bit RDM (MC68A30-8)	14 95
MC6850	Asynchronous Comm Adapter	7 95
MC6852	Synchronous Senal Data Adapt	9 95
MC6860	0-600 bps Digital MDDEM	12 95
MC6862	2400 bps Modulator	14 95
MC6880A	Quad 3-State Bus. Trans. (MC8T26)	2.25

MICROPROCESSOR CHIPS—MISCELLANEOUS

Z80(780C)	CPU	$19 95
Z80A(780-1)	CPU	24 95
CDP1802	CPU	19 95
2650	MPU	19 95
8035	8-Bit MPU w/clock, RAM, 1/0 lines	19 95
P8085	CPU	19 95
TMS9900JL	16-Bit MPU w/hardware, multiply & divide	49 95

SHIFT REGISTERS

MM500H	Dual 25 Bit Dynamic	$ 50
MM503H	Dual 50 Bit Dynamic	50
MM504H	Dual 16 Bit Static	.50
MM506H	Dual 100 Bit Static	.50
MM510H	Dual 64 Bit Accumulator	50
MM5016H	500/512 Bit Dynamic	89
2504T	1024 Dynamic	3 95
2518	Hex 32 Bit Static	4.95
2522	Dual 132 Bit Static	2 95
2524	512 Static	99
2525	1024 Dynamic	2 95
2527	Dual 256 Bit Static	2 95
2528	Dual 250 Static	4.00
2529	Dual 240 Bit Static	4 00
2532	Quad 80 Bit Static	2 95
2533	1024 Static	2.95
3341	Fifo	6 95
74LS670	4X4 Register File (TriState)	1 95

UART'S

A-Y-5-1013	30K BAUD	5 95

MICROPROCESSOR MANUALS

M-Z80	User Manual	$7 50
M-CDP1802	User Manual	7 50
M-2650	User Manual	5.00

ROM'S

2513(2140)	Character Generator(upper case)	$9 95
2513(3021)	Character Generator(lower case)	9 95
2516	Character Generator	10 95
MM5230N	2048-Bit Read Only Memory	1.95

RAM'S

1101	256X1	Static	$1 49
1103	1024X1	Dynamic	99
2101(8101)	256X4	Static	3 95
2102	1024X1	Static	1.75
21L02	1024X1	Static	1 95
2111(8111)	256X4	Static	3 95
2112	256X4	Static MOS	4 95
2114	1024X4	Static 450ns	9 95
2114L	1024X4	Static 450ns low power	10 95
2114-3	1024X4	Static 300ns	10 95
2114L-3	1024X4	Static 300ns low power	11 95
5101	256X4	Static	7 95
5280/2107	4096X1	Dynamic	4 95
7489	16X4	Static	1.75
74S200	256X1	Static Tnstate	4 95
93421	256X1	Static	2 95
UPD414 (MK4027)	4K	Dynamic 16 pin	4 95
UPD416 (MK4116)	16K	Dynamic 16 pin	14 95
TMS4044-45NL	4K	Static	14 95
TMS4045	1024X4	Static	14 95
2117	16,384X1	Dynamic 350ns (house marked)	9 95
MM5262	2KX1	Dynamic	4/1.00

PROM'S

1702A	2048	FAMDS	$5 95
TMS2516 (2716)	16K*	EPRDM(Intel 2716)	49 95
	*Requires single +5V power supply		
TMS2532	4KX8	EPRDM	89 95
2708	8K	EPRDM	10 95
2716 T.I	16K**	EPRDM	29 95
	**Requires 3 voltages, —5V, +5V, +12V		
5203	2048	FAMDS	14 95
6301-1(7611)	1024	Tnstate Bipolar	3.49
6330-1(7602)	256	Open C Bipolar	2 95
82S23	32X8	Open Collector	3 95
82S115	4096	Bipolar	19 95
82S123	32X8	Tnstate	3 95
74186	512	TTL Open Collector	9 95
74188	256	TTL Open Collector	3 95
74S287	1024	Static	2 95

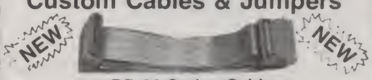
The Incredible "Pennywhistle 103"

$139.95 Kit Only

The Pennywhistle 103 is capable of recording data to and from audio tape without critical speed requirements for the recorder and it is able to communicate directly with another modern and terminal for telephone "hamming" and communications In addition, it is free of critical adjustments and is built with non-precision, readily available parts

Data Transmission Method .....Frequency-Shift Keying, full-duplex (half-duplex selectable)
Maximum Data Rate ....300 Baud
Data Format ....Asynchronous Serial (return to mark level required between each character)
Receive Channel Frequencies ...2025 Hz for space, 2225 Hz for mark
Transmit Channel Frequencies ..Switch selectable Low (normal) — 1070 space, 1270 mark, High — 025 space, 2225 mark
Receive Sensitivity .... — 46 dbm accoustically coupled
Transmit Level .... — 15 dbm nominal Adjustable from — 6 dbm to — 20 dbm
Receive Frequency Tolerance ...Frequency reference automatically adjusts to allow for operation between 1800 Hz and 2400 Hz
Digital Data Interface ....EIA RS-232C or 20 mA current loop (receiver is optoisolated and non-polar)
Power Requirements ....120 VAC, single phase, 10 Watts
Physical ....All components mount on a single 5" by 9" printed circuit board All components included
Requires a VOM, Audio Oscillator, Frequency Counter and/or Oscilloscope to align

Custom Cables & Jumpers



DB 25 Series Cables

Part No.	Cable Length	Connectors	Price
DB25P-4-P	4 Ft.	2-DP25P	$15.95 ea.
DB25P-4-S	4 Ft.	1-DP25P/1-25S	$16.95 ea.
DB25S-4-S	4 ft	2-DP25S	$17.95 ea.

Dip Jumpers

DJ14-1	1 ft.	1 14 Pin	$1 59 ea.
DJ16-1	1 ft.	1-16 Pin	1 79 ea.
DJ24-1	1 ft	1-24 Pin	2 79 ea.
DJ14-1-14	1 ft.	2-14 Pin	2.79 ea.
DJ16-1-16	1 ft.	2-16 Pin	3.19 ea.
DJ24-1-24	1 ft.	2-24 Pin	4.95 ea.

For Custom Cables & Jumpers, See JAMECO 1979 Catalog for Pricing

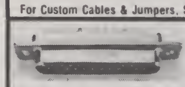
TRS-80 16K Conversion Kit

Expand your 4K TRS-80 System to 16K. Kit comes complete with:
* 8 each UPD416 (16K Dynamic Rams)
* Documentation for conversion

TRS-16K $115.00

Special Offer - Order both your TRS-16K and the Sup'R' MOD II Interface kit together (retail value $144.95) **for only $139.95**

CONNECTORS



25 Pin-D Subminiature

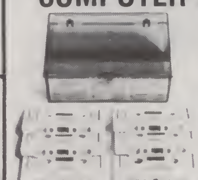
DB25P (as pictured)	PLUG (Meets RS232)		$2.95
DB25S	SOCKET (Meets RS232)		$3.50
DB51226-1	Cable Cover for DB25P or DB25S		$1.75

PRINTED CIRCUIT EDGE-CARD

156 Spacing-Tin-Double Read-Out — Bifurcated Contacts — Fits .054 to .070 P C Cards

15/30	PINS (Solder Eyelet)		$1.95
18/36	PINS (Solder Eyelet)		$2.49
22/44	PINS (Solder Eyelet)		$2.95
50/100 (.100 Spacing)	PINS (Wire Wrap)		$6.95
50/100 (.125 Spacing)	PINS (Wire Wrap)	R681-1	$6.95

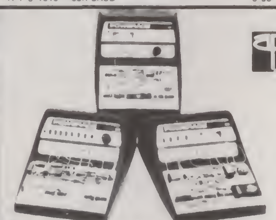
COMPUTER CASSETTES



- 6 EACH 15 MINUTE HIGH QUALITY C-15 CASSETTES
- PLASTIC CASE INCLUDED 12 CASSETTE CAPACITY
- ADDITIONAL CASSETTES AVAILABLE #C-15-$2.50 ea

CAS-6 $14.95
(Case and 6 Cassettes)

NEW!! IN STOCK... POWERACE

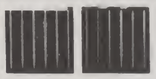


ALL-CIRCUIT EVALUATORS WITH POWER

- 1680 solderless, plug-in tie points will hold up to 18 14-pin DIP's
- Breadboard elements accept all DIP sizes including RTL, DTL, TTL and CMOS devices TO-5's and discretes with leads up to .032" dia
- All connections to/from switches, indicators, power supplies and meters are made via solderless, plug-in, tie-point blocks on control panels
- Interconnect with any solid 20 to 30 AWG wire
- Breadboard elements are mounted on ground planes. Ideal for high-frequency and high-speed/low-noise circuits
- Short-circuit-proof fused power supplies
- Operate on 110 to 130 VAC at 60 Hz
- Space-age compact styling and high-grade components permit convenient, organized and quick prototyping
- All models are 7 5" wide 11.5" deep and 4 0" high (rear) 0 75" high (front) and weigh approx. 2 5 lbs.

POWERACE 101 -General purpose model for prototyping all types of circuit.
#923101 $ 84.95
POWERACE 102 -Complete digit prototyping lab with built-in logic probe
#923102 $114.95
POWERACE 103 -Triple-output power supply for prototyping both linear and digit circuits.
#923103 $124.95

Solar Cells 2x2cm



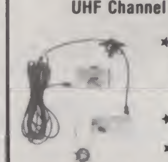
- 0.4 volts
- 100mA
- 41 MW

Can be added in series for higher voltage or parallel for higher current.

#SC 2x2 $1.95 ea. or 3/$5.00

SUP 'R' MOD II

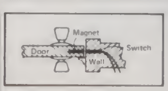
UHF Channel 33 TV Interface Unit Kit

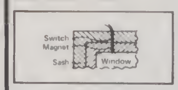


Wide Band B/W or Color System
* Converts TV to Video Display for home computers, CCTV camera, Apple II, works with Cromeco Dazzler, SOL-20, TRS-80, Challenger, etc.
* MOD II is pretuned to Channel 33 (UHF).
* Includes coaxial cable and antenna transformer.

MOD II $29.95 Kit

Magnetically Activated Switch





The 9250-0002 is a single pole normally closed switch. When the magnet is engaged, the circuit is open. This switch is only suitable for use in non-magnetic doors and windows.

#9250-0002 2/$1.00

BK PRECISION 3½-Digit Portable DMM

- Overload Protected
- 3 high LED Display
- Battery or AC operation
- Auto Zeroing
- 1mv 1Va 0 1 ohm resolution
- Overange reading
- 10 meg input impendence
- DC Accuracy 1% typical

Ranges: DC Voltage 0-1000V
AC Voltage 0-1000V
Freq Response 50-400 HZ
DC/AC Current 0-100mA
Resistance 0-10 meg ohm
Size 6 4 x 4 4 x 2

Model 2800 $99.95
Comes with test leads operating manual and spare fuse

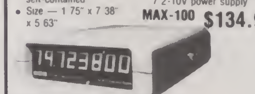
Accessories:
AC Adapter BC-28 $9.00
Rechargeable Batteries BP-26 20.00
Carrying Case LC-28 7.50

CSC 100 MHz 8-Digit Counter

CONTINENTAL SPECIALTIES CORPORATION

- 20 Hz-100 MHz Range
- 6" LED Display
- Crystal-controlled timebase
- Fully Automatic
- Portable — completely self-contained
- Size — 1 75" x 7 38" x 5 63"
- Four power souces, i e batteries, 110 or 220V with charger 12V with auto lighter adapter and external 7 2-10V power supply

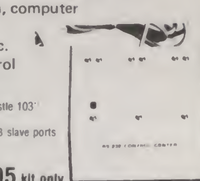
MAX-100 $134.95



ACCESSORIES FOR MAX 100:
Mobile Charger Eliminator use power from car battery **Model 100 — CLA $3.95**
Charger/Eliminator use 110 V AC **Model 100 — CAI $9.95**

RS-232 CONTROL CENTER

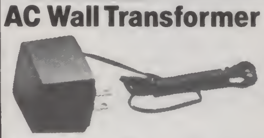
Plug in your modem, computer prom programmer, terminal, printer, etc. and selectively control data flow.



- Same Contour as "Pennywhistle 103"
- Totally self-contained
- Includes 2 master ports and 3 slave ports

PART NO. RS-232CC $89.95 kit only

AC Wall Transformer

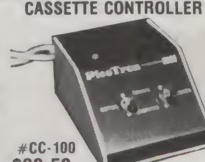


Ideal for use with clocks, power supplies or any other type of AC application.

Part No.	Input	Output	Price
AC 250	117V/60Hz	12 VAC 250mA	$3.95
AC 500	117V/60Hz	12 VAC 500mA	$4.95

CASSETTE CONTROLLER

Ideal for use with the TRS 80 and others.
"Plug/Jack interface to any computer system requiring remote control of cassette functions"
The CC100 controls cassette motor functions, monitors tape location with its internal speaker and requires no power. Eliminates the plugging and unplugging of cables during computer loading operation from cassette.



#CC-100 $29.50

Regulated Power Supply

- Uses LM 309K
- Heat sink provided
- P.C. board construction
- Provides a solid 1 amp @ 5V
- Includes components, hardware and instructions
- Sizes: 3-1/2" x 5" x 2" high

JE200 $14.95

New CSC Mini-Max 6 Digit 50MHz Frequency Counter

- Guaranteed frequency range of 100 Hz to 50 MHz
- Full 6 digit display with antiglare window
- Fully automatic-range, polarity, slope, trigger, input level switching not required.
- Lead-zero blanking—All zeros to the left of the first non-zero digit are blanked. Kilo Hertz and Mega Hertz decimal points automatically light up when the unit is turned on.
- Built in input overvoltage protection.
- Use 9V Battery or 110/220V power.
- Complete with mini antenna.
- Lightweight — Only 8oz.

MINI-MAX $89.95

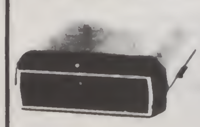
Accessories For Mini-Max

Part No.	Description	Price
MM-A4	Antenna	$ 3.95
MM-C5	Carrying case	5.95
MM-IPC	Input cable with clip leads	3.95
MM-AC2	110V adapter	9.95
MM-AC3	220V adapter	9.95

63-Key Unencoded Keyboard

This is a 63-key, terminal keyboard newly manufactured by a large computer manufacturer. It is unencoded with SPST keys, unattached to any kind of PC board. A very solid molded plastic 13 x 4" base suits most application. IN STOCK **$29.95/each**

INSTRUMENT/CLOCK CASE



This case is an injection molded unit that is ideal for uses such as DVM, COUNTER, or CLOCK cases. It has dimensions of 4½" in length by 4" in width by 1-9/16" in height. It comes complete with a red bezel.

PART NO: IN-CC $3.49 each

$5.00 Minimum Order – U.S. Funds Only
California Residents – Add 6% Sales Tax
Spec Sheets – 25¢
1979 Catalog Available—Send 41¢ stamp

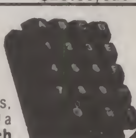
NEW 1979 Catalog

Jameco ELECTRONICS
a division of JAMES ELECTRONICS of California

PHONE ORDERS WELCOME (415) 592-8097

MAIL ORDER ELECTRONICS – WORLDWIDE
1021 HOWARD AVENUE, SAN CARLOS, CA 94070
ADVERTISED PRICES GOOD THRU MARCH

Hexadecimal Unencoded Keypad



19-key pad includes 1-10 keys, ABCDEF and 2 optional keys and a shift key. **$10.95/each**

7400 TTL

SN7400N	.18	SN7470N	.29	SN74160N	.89
SN7401N	.18	SN7472N	.29	SN74161N	.89
SN7402N	.18	SN7473N	.35	SN74162N	1.95
SN7403N	.18	SN7474N	.35	SN74163N	.89
SN7404N	.18	SN7475N	.49	SN74164N	.89
SN7405N	.20	SN7476N	.35	SN74165N	.89
SN7406N	.29	SN7479N	5.00	SN74166N	1.25
SN7407N	.29	SN7480N	.50	SN74167N	1.95
SN7408N	.20	SN7482N	.99	SN74170N	1.59
SN7409N	.20	SN7483N	.59	SN74172N	6.00
SN7410N	.18	SN7485N	.79	SN74173N	1.25
SN7411N	.25	SN7486N	.35	SN74174N	.89
SN7412N	.25	SN7489N	1.75	SN74175N	.79
SN7413N	.40	SN7490N	.45	SN74176N	.79
SN7414N	.70	SN7491N	.59	SN74177N	.79
SN7416N	.25	SN7492N	.43	SN74179N	1.95
SN7417N	.25	SN7493N	.43	SN74180N	.79
SN7420N	.20	SN7494N	.65	SN74181N	1.95
SN7421N	.29	SN7495N	.65	SN74182N	.79
SN7422N	.39	SN7496N	.65	SN74184N	1.95
SN7423N	.25	SN7497N	3.00	SN74185N	1.95
SN7425N	.29	SN74100N	.89	SN74186N	9.95
SN7426N	.29	SN74107N	.35	SN74188N	3.95
SN7427N	.29	SN74109N	.59	SN74190N	1.25
SN7429N	.39	SN74116N	1.95	SN74191N	1.25
SN7430N	.20	SN74121N	.35	SN74192N	.79
SN7432N	.25	SN74122N	.39	SN74193N	.79
SN7437N	.25	SN74123N	.49	SN74194N	.89
SN7438N	.25	SN74125N	.49	SN74195N	.69
SN7439N	.25	SN74126N	.49	SN74196N	.89
SN7440N	.20	SN74132N	.75	SN74197N	.89
SN7441N	.89	SN74136N	.75	SN74198N	1.49
SN7442N	.49	SN74141N	.79	SN74199N	1.49
SN7443N	.75	SN74142N	2.95	SN74S200	4.95
SN7444N	.75	SN74143N	2.95	SN74251N	1.79
SN7445N	.75	SN74144N	2.95	SN74279N	.79
SN7446N	.69	SN74145N	.79	SN74283N	2.25
SN7447N	.59	SN74147N	1.95	SN74284N	3.95
SN7448N	.79	SN74148N	1.29	SN74285N	3.95
SN7450N	.20	SN74150N	.89	SN74365N	.69
SN7451N	.20	SN74151N	.59	SN74366N	.69
SN7453N	.20	SN74152N	.59	SN74367N	.69
SN7454N	.20	SN74153N	.59	SN74368N	.69
SN7459A	.25	SN74154N	.99	SN74390N	1.95
SN7460N	.20	SN74155N	.79	SN74393N	1.95
		SN74156N	.79		
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CD4006	1.19	CD4035	.99	CD4076	1.39
CD4007	.25	CD4040	1.19	CD4081	.23
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CD4010	.49	CD4042	.99	CD4093	.99
CD4011	.23	CD4043	.89	CD4098	2.49
CD4012	.25	CD4044	.89	MC14409	14.95
CD4013	.39	CD4046	1.79	MC14410	14.95
CD4014	1.39	CD4047	2.50	MC14411	14.95
CD4015	1.19	CD4048	1.35	MC14419	4.95
CD4016	.49	CD4049	.49	MC14433	19.95
CD4017	1.19	CD4050	.49	MC14506	.75
CD4018	.99	CD4051	1.19	MC14507	.99
CD4019	.49	CD4053	1.19	MC14562	14.50
CD4020	1.19	CD4056	2.95	MC14583	3.50
CD4021	1.39	CD4059	9.95	CD4508	3.95
CD4022	1.19	CD4060	1.49	CD4510	1.39
CD4023	.23	CD4066	.79	CD4511	1.29
CD4024	.79	CD4068	.39	CD4515	2.95
CD4025	.23	CD4069	.45	CD4518	1.29
CD4026	2.25			CD4520	1.29
CD4027	.69			CD4566	2.25

74C00

74C00	.39	74C85	2.49	74C163	2.49
74C02	.39	74C90	1.95	74C164	2.49
74C04	.39	74C93	1.95	74C173	2.60
74C08	.49	74C95	1.95	74C192	2.49
74C10	.39	74C107	1.25	74C193	2.49
74C14	1.95	74C151	2.90	74C195	2.49
74C20	.39	74C154	3.00	74C922	5.95
74C30	.39	74C157	2.15	74C923	6.25
74C42	1.95	74C160	2.49	74C925	8.95
74C48	2.49	74C161	2.49	74C926	8.95
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74C74	.89			80C97	1.50

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78MG	1.75	LM340K-18	1.35	LM710N	.79
LM106H	.99	LM340K-24	1.35	LM711N	.39
LM300H	.80	LM340T-5	1.25	LM723N/H	.55
LM301CN/H	.35	LM340T-6	1.25	LM733N	1.00
LM302H	.75	LM340T-8	1.25	LM739N	1.19
LM304H	1.00	LM340T-12	1.25	LM741CN/H	.35
LM305H	.60	LM340T-15	1.25	LM741-14N	.39
LM307CN/H	.35	LM340T-18	1.25	LM747N/H	.79
LM308CN/H	1.00	LM340T-24	1.25	LM748N/H	.39
LM309H	1.10	LM358N	1.00	LM1310N	2.95
LM309K	1.25	LM370N	1.95	LM1458CN/H	.59
LM310CN	1.15	LM373N	3.25	MC1488N	1.95
LM311N/H	.90	LM377N	4.00	MC1489N	1.95
LM312H	1.95	LM380N	1.25	LM1496N	.95
LM317K	6.50	LM380CN	.99	LM1556V	1.75
LM318CN/H	1.50	LM381N	1.79	MC1741SCP	3.00
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LM320K-5.2	1.35	NE510A	6.00	LM3053N	1.50
LM320K-12	1.35	NE529A	4.95	LM3065N	1.49
LM320K-15	1.35	NE531H/V	3.95	LM3900N(3401)	.49
LM320K-18	1.35	NE536T	6.00	LM3905N	.89
LM320K-24	1.35	NE540L	6.00	LM3909N	1.25
LM320T-5	1.25	NE544N	4.95	MC5558V	.59
LM320T-5.2	1.25	NE550N	1.30	8038B	4.95
LM320T-8	1.25	NE555V	.39	LM75450N	.49
LM320T-12	1.25	NE556N	.99	75451CN	.39
LM320T-15	1.25	NE560B	5.00	75452CN	.39
LM320T-18	1.25	NE561B	5.00	75453CN	.39
LM320T-24	1.25	NE562B	5.00	75454CN	.39
LM323K-5	5.95	NE565N/H	.99	75491CN	.79
LM324N	1.80	NE566CN	1.75	75492CN	.89
LM339N	.99	NE567V/H	.99	75493N	.89
LM340K-5	1.35	NE570N	4.95	75494CN	.89
LM340K-6	1.35	LM703CN/H	.69	RC4136	1.25
LM340K-8	1.35	LM709N/H	.29	RC4151	5.95
LM340K-12	1.35			RC4194	5.95
LM340K-15	1.35			RC4195	4.49

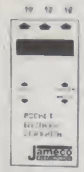
74LS00TTL

74LS00	.23	74LS47	.69	74LS138	.69
74LS01	.23	74LS51	.23	74LS139	.69
74LS02	.23	74LS54	.23	74LS151	.69
74LS03	.23	74LS55	.23	74LS155	.69
74LS04	.29	74LS73	.35	74LS157	.69
74LS05	.29	74LS74	.35	74LS160	.89
74LS08	.29	74LS75	.49	74LS161	.89
74LS09	.29	74LS76	.35	74LS162	.89
74LS10	.29	74LS78	.39	74LS163	.89
74LS11	.60	74LS83	.75	74LS164	.99
74LS13	.49	74LS85	.99	74LS175	.79
74LS14	.99	74LS86	.35	74LS181	2.49
74LS15	.29	74LS90	.49	74LS190	.89
74LS20	.23	74LS92	.59	74LS191	.89
74LS21	.29	74LS93	.59	74LS192	.89
74LS22	.29	74LS95	.79	74LS193	.89
74LS26	.29	74LS96	.89	74LS194	.89
74LS27	.29	74LS107	.35	74LS195	.89
74LS28	.29	74LS109	.35	74LS253	.79
74LS30	.23	74LS112	.35	74LS257	.69
74LS32	.29	74LS123	.99	74LS258	1.39
74LS37	.35	74LS125	.69	74LS260	.55
74LS40	.29	74LS132	.79	74LS279	.59
74LS42	.69	74LS136	.39	74LS367	.59
				74LS368	.59
				74LS670	1.95

Jameco ELECTRONICS (New) **Kits**

a division of JAMES ELECTRONICS of California

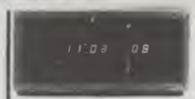
Digital Stopwatch Kit



- Use Intersil 7205 Chip
- Plated thru double-sided P.C. Board
- LED display (red)
- Times to 59 min. 59.59 sec. with auto reset
- Quartz crystal controlled
- Three stopwatches in one single event, split (cummulative) and taylor (sequential timing)
- Uses 3 penlite batteries
- Size: 4.5" x 2.15" x .90"

JE900 $39.95

6-Digit Clock Kit



- Bright .300 ht. common cathode display
- Uses MM5314 clock chip
- Switches for hours, minutes and hold functions
- Hours easily viewable to 20 feet
- Simulated walnut case
- 115 VAC operation
- 12 or 24 hour operation
- Includes all components, case and wall transformer
- Size: 6-3/4" x 3-1/8" x 1-3/4"

JE701 $19.95

ALSO AVAILABLE:

JE200	5v lamp power supply	$14.95	JE2206B	Function Generator	$19.95
JE730	4-digit clock kit	14.95	JE747	Jumbo 6-digit clock kit	29.95

DISCRETE LEDS

.200" dia.			.125" dia.		
XC556R	red	5/$1	XC209R	red	5/$1
XC556G	green	4/$1	XC209G	green	4/$1
XC556Y	yellow	4/$1	XC209Y	yellow	4/$1
XC556C	clear	4/$1			
.200" dia.			.185" dia.		
XC22R	red	5/$1	XC526R	red	5/$1
XC22G	green	4/$1	XC526G	green	4/$1
XC22Y	yellow	4/$1	XC526Y	yellow	4/$1
.170" dia.			XC526C	clear	4/$1
MV10B	red	4/$1	.190" dia.		
.085" dia.			XC111R	red	5/$1
MV50	red	6/$1	XC111G	green	4/$1
INFRA-RED LED 1/4"x1/4"x1/16" flat		5/$1	XC111Y	yellow	4/$1
			XC111C	clear	4/$1

TIMEX T1001
LIQUID CRYSTAL DISPLAY
FIELD EFFECT

4 DIGIT - .5" CHARACTERS
THREE ENUNCIATORS
2.00" X 1.20" PACKAGE
INCLUDES CONNECTOR

T1001-Transmissive	$7.95
T1001A-Reflective	8.25

DISPLAY LEDS

TYPE	POLARITY	HT	PRICE	TYPE	POLARITY	HT	PRICE
MAN 1	Common Anode-red	.270	2.95	MAN 6730	Common Anode-red ± 1	.560	.99
MAN 2	5 x 7 Dot Matrix-red	.300	4.95	MAN 6740	Common Cathode-red-D.D.	.560	.99
MAN 3	Common Cathode-red	.125	.25	MAN 6750	Common Cathode-red ± 1	.560	.99
MAN 4	Common Cathode-red	.187	1.95	MAN 6760	Common Anode-red	.560	.99
MAN 7G	Common Anode-green	.300	1.25	MAN 6780	Common Cathode-red	.560	.99
MAN 7Y	Common Anode-yellow	.300	.99	DL701	Common Anode-red ± 1	.300	.99
MAN 72	Common Anode-red	.300	.99	DL704	Common Cathode-red	.300	.99
MAN 74	Common Cathode-red	.300	1.25	DL707	Common Anode-red	.300	.99
MAN 82	Common Anode-yellow	.300	.99	DL728	Common Cathode-red	.500	1.49
MAN 84	Common Cathode-yellow	.300	.99	DL741	Common Anode-red	.600	1.25
MAN 3620	Common Anode-orange	.300	.99	DL746	Common Anode-red ± 1	.630	1.49
MAN 3630	Common Anode-orange ± 1	.300	.99	DL747	Common Anode-red	.600	1.49
MAN 3640	Common Cathode-orange	.300	.99	DL749	Common Cathode-red ± 1	.630	1.49
MAN 4610	Common Anode-orange	.300	.99	DL750	Common Cathode-red	.600	1.49
MAN 4640	Common Cathode-orange	.400	.99	DL338	Common Cathode-red	.110	.35
MAN 4710	Common Anode-red	.400	.99	FND70	Common Cathode	.250	.69
MAN 4730	Common Anode-red ± 1	.400	.99	FND358	Common Cathode ± 1	.357	.99
MAN 4740	Common Cathode-red	.400	.99	FND359	Common Cathode	.357	.75
MAN 4810	Common Anode-yellow	.400	.99	FND503	Common Cathode(FND500)	.500	.99
MAN 4840	Common Cathode-yellow	.400	.99	FND507	Common Anode (FND510)	.500	.99
MAN 6610	Common Anode-orange-D.D.	.560	.99	5082-7730	Common Anode-red	.300	1.30
MAN 6630	Common Anode-orange ± 1	.560	.99	HDSP-3400	Common Anode-red	.800	2.10
MAN 6640	Common Cathode-orange-D.D.	.560	.99	HDSP-3403	Common Cathode red	.800	2.10
MAN 6650	Common Cathode-orange ± 1	.560	.99	5082-7300	4 x 7 Sgl. Digit-RHDP	.600	19.95
MAN 6660	Common Anode-orange	.560	.99	5082-7302	4 x 7 Sgl. Digit-LHDP	.600	19.95
MAN 6680	Common Cathode-orange	.560	.99	5082-7304	Overrange character (±1)	.600	15.00
MAN 6710	Common Anode-red-D.D.	.560	.99	5082-7340	4 x 7 Sgl. Digit-Hexadecimal	.600	22.50

RCA LINEAR

CA3013T	2.15	CA3082N	2.00
CA2023T	2.56	CA3083N	1.60
CA3035T	2.48	CA3086N	.85
CA3039T	1.35	CA3089N	3.75
CA3046N	1.30	CA3130T	1.39
CA3059N	3.25	CA3140T	1.25
CA3060N	3.25	CA3160T	1.25
CA3080T	.85	CA3401N	.49
CA3081N	2.00	CA3600N	3.50

CALCULATOR CHIPS/DRIVERS

MM5725	$2.95
MM5738	2.95
DM8864	2.00
DM8865	1.00
DM8887	.75
DM8889	.75
9374 7 seg C.A. LED driver	

CLOCK CHIPS

MM5309	$4.95
MM5311	4.95
MM5312	4.95
MM5314	4.95
MM5316	6.95
MM5318	9.95
MM5369	2.95
MM5387/1998A	4.95
MM5841	9.95

MOTOROLA

MC1408L7	$4.95
MC1408L8	5.75
MC1439L	2.95
MC3022P	2.95
MC3061P	3.50
MC4016(74416)	7.50
MC4024P	3.95
MC4040P	6.95
MC4044P	4.50

IC SOLDERTAIL — LOW PROFILE (TIN) SOCKETS

	1-24	25-49	50-100		1-24	25-49	50-100
8 pin LP	$.17	.16	.15	22 pin LP	$.37	.36	.35
14 pin LP	.20	.19	.18	24 pin LP	.38	.37	.36
16 pin LP	.22	.21	.20	28 pin LP	.45	.44	.43
18 pin LP	.29	.28	.27	36 pin LP	.60	.59	.58
20 pin LP	.34	.32	.30	40 pin LP	.63	.62	.61

SOLDERTAIL STANDARD (TIN)

	1-24	25-49	50-100		1-24	25-49	50-100
14 pin ST	$.27	.25	.24	28 pin ST	$.99	.90	.81
16 pin ST	.30	.27	.25	36 pin ST	1.39	1.26	1.15
18 pin ST	.35	.32	.30	40 pin ST	1.59	1.45	1.30
24 pin ST	.49	.45	.42				

SOLDERTAIL STANDARD (GOLD)

	1-24	25-49	50-100		1-24	25-49	50-100
8 pin SG	$.30	.27	.24	24 pin SG	$.70	.63	.57
14 pin SG	.35	.32	.29	28 pin SG	1.10	1.00	.90
16 pin SG	.38	.35	.32	36 pin SG	1.65	1.40	1.26
18 pin SG	.52	.47	.43	40 pin SG	1.75	1.59	1.45

WIRE WRAP SOCKETS (GOLD) LEVEL #3

	1-24	25-49	50-100		1-24	25-49	50-100
8 pin WW	$.39	.38	.31	22 pin WW	$.95	.85	.75
10 pin WW	.45	.41	.37	24 pin WW	1.05	.95	.85
14 pin WW	.39	.38	.37	28 pin WW	1.40	1.25	1.10
16 pin WW	.43	.42	.41	36 pin WW	1.59	1.45	1.30
18 pin WW	.75	.68	.62	40 pin WW	1.75	1.55	1.40

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ASST. 1	5 ea	10 OHM / 22 OHM	12 OHM / 33 OHM	15 OHM / 39 OHM	18 OHM / 47 OHM	27 OHM / 56 OHM	50 PCS	$1.75
ASST. 2	5 ea	68 OHM / 180 OHM	82 OHM / 220 OHM	100 OHM / 270 OHM	120 OHM / 330 OHM	150 OHM / 390 OHM	50 PCS	1.75
ASST. 3	5 ea	470 OHM / 1.2K	560 OHM / 1.5K	680 OHM / 1.8K	820 OHM / 2.2K	1K / 2.7K	50 PCS	1.75
ASST. 4	5 ea	3.3K / 8.2K	3.9K / 10K	4.7K / 12K	5.6K / 15K	6.8K / 18K	50 PCS	1.75
ASST. 5	5 ea	22K / 56K	27K / 68K	33K / 82K	39K / 100K	47K / 120K	50 PCS	1.75
ASST. 6	5 ea	150K / 390K	180K / 470K	220K / 560K	270K / 680K	330K / 820K	50 PCS	1.75
ASST. 7	5 ea	1M / 2.7M	1.2M / 3.3M	1.5M / 3.9M	1.8M / 4.7M	2.2M / 5.6M	50 PCS	1.75

ASST. 8R Includes Resistor Assortments 1-7 (350 PCS.) **$9.95 ea.**

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XR215	4.40			XR2556	3.20
XR320	1.55	JE2206KA	14.95	XR2567	2.99
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XR555	.39	XR1800	3.20	XR4136	1.25
XR556	.99	XR2206	4.40	XR4151	2.85
XR567CP	.99	XR2207	3.85	XR4194	1.45
XR567CT	1.25	XR2208	5.20	XR4202	3.60
XR1310P	1.30	XR2209	1.75	XR4212	2.05
XR1468CN	3.85	XR2211	5.25	XR4558	.75
XR1488	1.39	XR2212	4.35	XR4739	1.15
XR1489	1.39	XR2240	3.45	XR4741	1.47

DIODES

TYPE	VOLTS	W	PRICE	TYPE	VOLTS	W	PRICE
				1N4002	100 PIV	1 AMP	12/1.00
				1N4003	200 PIV	1 AMP	12/1.00
1N746	3.3	400m	4/1.00	1N4004	400 PIV	1 AMP	12/1.00
1N751	5.1	400m	4/1.00	1N4005	600 PIV	1 AMP	10/1.00
1N752	5.6	400m	4/1.00	1N4006	800 PIV	1 AMP	10/1.00
1N753	6.2	400m	4/1.00	1N4007	1000 PIV	1 AMP	10/1.00
1N754	6.8	400m	4/1.00	1N3600	50	200m	6/1.00
1N757	9.0	400m	4/1.00	1N4148	75	10m	15/1.00
1N759	12.0	400m	4/1.00	1N4154	35	10m	12/1.00
1N959	8.2	400m	4/1.00	1N4305	75	25m	15/1.00
1N965	15	400m	4/1.00	1N4734	5.6	1w	.28
1N5232	5.6	500m	.28	1N4735	6.2	1w	.28
1N5234	6.2	500m	.28	1N4736	6.8	1w	.28
1N5235	6.8	500m	.28	1N4738	8.2	1w	.28
1N5236	7.5	500m	.28	1N4742	12	1w	.28
1N5242	12	500m	.28	1N4744	15	1w	.28
1N5245	15	500m	.28	1N1183	50 PIV	35 AMP	1.60
1N456	25	40m	6/1.00	1N1184	100 PIV	35 AMP	1.70
1N458	150	7m	6/1.00	1N1185	150 PIV	35 AMP	1.70
1N485A	180	10m	5/1.00	1N1186	200 PIV	35 AMP	1.80
1N4001	50 PIV	1 AMP	12/1.00	1N1188	400 PIV	35 AMP	3.00

SCR AND FW BRIDGE RECTIFIERS

C36D	15A @ 400V	SCR(2N1849)	$1.95
C38M	35A @ 600V	SCR	1.95
2N2328	1.6A @ 300V	SCR	.50
MDA 980-1	12A @ 50V	FW BRIDGE REC.	1.95
MDA 980-3	12A @ 200V	FW BRIDGE REC.	1.95

TRANSISTORS

C106B1	.50			2N3904	4/1.00
MPSA05	.30	2N3055	.89	2N3905	4/1.00
MPSA06	5/1.00	MJE3055	1.00	2N3906	4/1.00
TIS97	6/1.00	2N3392	5/1.00	2N4013	3/1.00
TIS98	6/1.00	2N3398	5/1.00	2N4123	6/1.00
40409	1.75	PN3567	3/1.00	PN4249	4/1.00
40410	1.75	PN3568	4/1.00	PN4250	4/1.00
40673	1.75	PN3569	4/1.00	2N4400	4/1.00
2N918	4/1.00	MPS3638A	5/1.00	2N4401	4/1.00
2N2219A	2/1.00	MPS3702	5/1.00	2N4402	4/1.00
2N2221A	4/1.00	2N3704	5/1.00	2N4403	4/1.00
2N2222A	5/1.00	MPS3704	5/1.00	2N4409	5/1.00
PN2222 Plastic	7/1.00	2N3705	5/1.00	2N5086	4/1.00
2N2369	5/1.00	MPS3705	5/1.00	2N5087	4/1.00
2N2369A	4/1.00	2N3706	5/1.00	2N5088	4/1.00
MPS2369	5/1.00	MPS3706	5/1.00	2N5089	4/1.00
2N2484	4/1.00	2N3707	5/1.00	2N5129	5/1.00
2N2906	4/1.00	2N3711	5/1.00	PN5134	5/1.00
2N2907	5/1.00	2N3724A	.65	PN5138	5/1.00
PN2907 Plastic	7/1.00	2N3725A	1.00	2N5139	5/1.00
2N2925	5/1.00	2N3772	2.25	2N5210	5/1.00
MJE2955	1.25	2N3823	1.00	2N5449	3/1.00
2N3053	2/1.00	2N3903	5/1.00	2N5951	3/1.00

CAPACITOR CORNER

50 VOLT CERAMIC DISC CAPACITORS

	1-9	10-99	100-		1-9	10-99	100-
10 pf	.05	.04	.03	.001µF	.05	.04	.035
22 pf	.05	.04	.03	.0047µF	.05	.04	.035
47 pf	.05	.04	.03	.01µF	.05	.04	.035
100 pf	.05	.04	.03	.022µF	.06	.05	.04
220 pf	.05	.04	.03	.047µF	.06	.05	.04
470 pf	.05	.04	.035	.1µF	.12	.09	.075
100 VOLT MYLAR FILM CAPACITORS							
.001mf	.12	.10	.07	.022mf	.13	.11	.08
.0022	.12	.10	.07	.047mf	.21	.17	.13
.0047mf	.12	.10	.07	.1mf	.27	.23	.17
.01mf	.12	.10	.07	.22mf	.33	.27	.22
+20% DIPPED TANTALUMS (SOLID) CAPACITORS							
.1/35V	.28	.23	.17	1.5/35V	.30	.26	.21
.15/35V	.28	.23	.17	2.2/25V	.31	.27	.22
.22/35V	.28	.23	.17	3.3/25V	.31	.27	.22
.33/35V	.28	.23	.17	4.7/25V	.32	.28	.23
.47/35V	.28	.23	.17	6.8/25V	.36	.31	.25
.68/35V	.28	.23	.17	10/25V	.40	.35	.29
1.0/35V	.28	.23	.17	15/25V	.63	.50	.40
MINIATURE ALUMINUM ELECTROLYTIC CAPACITORS							
Axial Lead				Radial Lead			
.47/50V	.15	.13	.10	.47/25V	.15	.13	.10
1.0/50V	.16	.14	.11	.47/50V	.16	.14	.11
3.3/50V	.14	.12	.09	1.0/16V	.15	.13	.10
4.7/25V	.15	.13	.10	1.0/25V	.16	.14	.11
10/25V	.15	.13	.10	1.0/50V	.16	.14	.11
10/50V	.16	.14	.12	4.7/16V	.15	.13	.10
22/25V	.17	.15	.12	4.7/25V	.15	.13	.10
22/50V	.24	.20	.18	4.7/50V	.16	.14	.11
47/25V	.19	.17	.15	10/16V	.14	.12	.09
47/50V	.25	.21	.19	10/25V	.15	.13	.10
100/25V	.24	.20	.18	10/50V	.16	.14	.12
100/50V	.35	.30	.28	47/50V	.24	.21	.19
220/25V	.32	.28	.25	100/16V	.19	.15	.14
220/50V	.45	.41	.38	100/25V	.24	.20	.18
470/25V	.33	.29	.27	100/50V	.35	.30	.28
1000/16V	.55	.50	.45	220/16V	.23	.17	.16
2200/16V	.70	.62	.55	470/25V	.31	.28	.26

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100 mV DC F.S. SENSITIVITY
19 RANGES AND FUNCTIONS

Here is the handfull of accuracy you've been waiting for. Handsomely encased. Compact. Efficient. Only 8 ounces. Hickok's exciting, new LX 303, 3½ digit Mini-Multimeter with high quality components, one year guarantee and rugged Cycolac® case offers features previously found only in expensive units . . . at a price under $75.00! So why wait any longer? The amazing LX 303 is here, NOW! Another American made test equipment breakthrough from Hickok.

SPECIFICATIONS

DC VOLTS (5 RANGES): 0.1mV to 1000V; Accuracy ±0.5% rdg ±0.5% f.s.; Input Imped: 10MΩ; Max. Input 1kV except 500V on 200mV range.
AC VOLTS (40Hz to 5kHz): 0.1V to 600V; Accuracy: ±1.0% rdg ±0.5% f.s. (—2dB max. at 5kHz); Max. Input: 600V.
RESISTANCE (6 LOW POWER RANGES): 0.1Ω to 20MΩ; Accuracy: ±.05% rdg ±0.5% f.s. (±1.5% rdg on 20MΩ range); input protected to 120VAC all ranges.
DC CURRENT (6 RANGES): .01nA to 100mA; Accuracy: ±1.0% rdg ±0.5% f.s.
DIMENSIONS AND WEIGHT: 5-7/8" x 3-3/8" x 1-3/4", 8 oz.; POWER: 9V battery (not included) or Hickok AC adapter; READ RATE: 3/sec.

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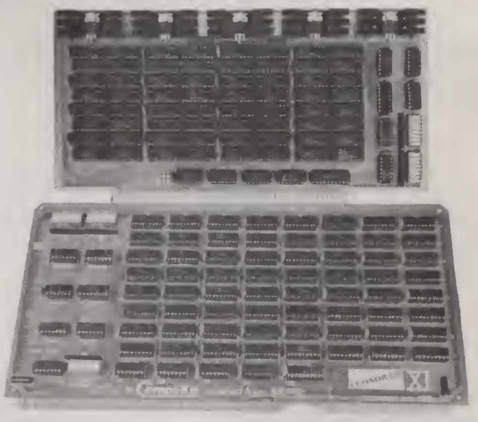

● 4MHz operation guaranteed on high-density (16K and up) boards, with no price penalty ● Low current consumption with guaranteed specs ● Static technology used exclusively ● Buffered inputs for minimum buss loading ● Buffered tri-state outputs for maximum output drive ● Unique multi-block configurations for addressing flexibility ● All memories conform to industry standard board sizes ● 1 year limited warranty (not just 90 days) ● Double-sided, plate through, solder masked and legended circuit board ● Complete documentation ● Gold-plated edge connector teeth that stand up to repeated insertions ● DIP switch address selection/deselection ● Sockets for all ICs, including low power Schottky support chips ● Optimized thermal design ● Over 4 years of experience in the design and manufacture of memories

Most Econorams are available in 3 forms: **unkit** (sockets, bypass caps pre-soldered in place for easy assembly); **assembled and tested**; or qualified under the **Certified System Component (CSC)** high-reliability program (200 hour burn-in, 4 MHz operation over full temperature range, serial numbered, immediate replacement in event of failure within 1 year of invoice date).

NAME	STORAGE	BUSS	SPEED	UNKIT	ASSM	CSC
ECONORAM II™	8K X 8	S-100	2 MHz	$139	$159	N/A
ECONORAM IV™	16K X 8	S-100	4 MHz	$295	$329	$429
ECONORAM VI™	12K X 8	Heath H8	2 MHz	$200	$270	N/A
ECONORAM VII™	24K X 8	S-100	4 MHz	$445	$485	$605
ECONORAM IX™	32K X 8	Dig Group	4 MHz	$649	N/A	N/A
ECONORAM X™	32K X 8	S-100	4 MHz	$599	$649	$789
ECONORAM XI™	32K X 8	Intel/National 80/10 & 80/20	4 MHz	N/A	N/A	$1050

OTHER MEMORY PRODUCTS AND SPECIALTY ITEMS

TRS-80 CONVERSION KIT $109

Our kit is guaranteed for 1 year, includes DIP shunts, and uses 240 ns chips for operation at 4 MHz. Upgrades 4K TRS-80 to 16K or populates Memory Expansion Module; our novice level instructions make it easy. **Also expands memory in Apple and Exidy Sorcerer computers. 3 kits/$320.**

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2102L-1 (low power, better than 450 ns) 1K static RAMs **now only 99¢ while they last.** Only good on orders of 10 or more.

TMS4044 4K static RAMs, 450 ns, prime parts — **$7.95 each, 8 or more $6.95 each, 32 or more $5.95 each, 64 or more $4.95 each. While they last.**

HEATH H8 BARE BOARD MEMORY SPECIAL $35

Don't need the full 12K of our standard H8 memory? We now offer the board, mounting bracket, edge connector, and print for only $35. Populate it with a few support chips and readily available, low cost 2102s to build your memory up to a full 12K whenever your budget permits.

ACTIVE TERMINATOR KIT $29.50

Our much imitated design plugs into any S-100 motherboard slot to treat the S-100 buss as the RF system it really is, thereby reducing noise, glitches, ringing, overshoot, and other buss-related problems. Improves reliability, saves power compared to passive termination.

PET TO S-100 INTERFACE BOARD $199.95

From HUH Electronics (designed by Mark Garetz). Mates S-100 boards to the Commodore PET, or serves as nucleus of stand-alone 6500 series system.

11 SLOT S-100 MOTHERBOARD UNKIT $90

Includes 11 edge connectors soldered in place for simplified assembly, and active termination for reliable data transfer. Dimensions: 8.5″ × 11″.

18 SLOT S-100 MOTHERBOARD UNKIT $124

Same as above, but 18 slots and edge connectors. Dimensions 8.5″ × 16.7″.

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We've got some great new products up our sleeves. How about 16K and 24K **bank select** memories (perfect for the Alpha Microsystems machine)? Or a memory management board that retrofits S-100 machines (Altair, IMSAI, etc.) so that they can address half-a-Megabyte of memory? Then there's our super S-100 I/O board, with two hardware UARTs (no software UARTS that tie up your buss), full RS-232 specs, handshaking, and true S-100 compatibility . . . well worth waiting for. Watch this space for details in the months ahead.

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- Automatic polarity, decimal and overload indication
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R681-3 50/100 Cont 125 ctrs. PIERCED SOLDER EYELET tails GOLD
$7.53

Other Popular Edge Connectors

R644-G 22/44 Cont 156 ctrs PIERCED SOLDER EYLET tails. GOLD plated

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R644-3 22/44 Cont 156 ctrs. WIRE WRAP tails GOLD

1-4	5-9	10-24
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CG-1 IMSAI Style Card Guides 5/$1.00
ATTN: OEM's and Dealers, many other connectors available call or quotation

3 LEVEL GOLD WIRE WRAP SOCKETS

Sockets purchased in multiples of 50 per type may be combined for best price.

	1-24	25-49	50-99	100-249	250-999	1K-5K
8 pin*	.41	.38	.35	.31	.27	.23
14 pin*	.39	.38	.36	.32	.29	.27
16 pin*	.43	.42	.39	.35	.32	.30
18 pin	.63	.58	.54	.47	.42	.36
20 pin	.80	.75	.70	.63	.58	.53
22 pin*	.90	.85	.80	.70	.61	.57
24 pin	.90	.84	.78	.68	.63	.58
28 pin	1.10	1.00	.90	.84	.76	.71
40 pin	1.50	1.40	1.30	1.20	1.04	.89

All sockets are GOLD 3 level closed entry * End and side stacable. 2 level, Solder Tail, Low Profile, Tin Sockets and Dip Plugs available CALL FOR QUOTATION

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- LCD-101 or LCD-102 your choice **$34.95 ea**
- Clear desk stand for **$2.00**

12:20

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- Solder mask with solder windows on etched circuits to avoid accidental short circuits
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- Includes etched circuits and instructions for option of active, pull-up, or floating terminations
- Large buses +5V and GND (10 AMPS), ± 12V or 16V (7 AMPS). Current ratings are per MIL-STD-275 with 10°C rise
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Universal Microcomputer/processor plugboard, use with S-100 bus. Complete with heat sink & hardware 5.3" x 10" x 1/16"

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1/16 Vector BOARD

.042 dia holes on 0.1 spacing for IC's

Phenolic		PRICE	
PART NO.	SIZE	1-9	10-19
64P44XXXP	4.5x6.5"	$1.56	$1.40
169P44XXXP	4.5x17"	$3.69	$3.32
Epoxy Glass			
64P44	4.5x6.5"	$1.79	$1.61
84P44	4.5x8.5"	$2.21	$1.99
169P44	4.5x17"	$4.52	$4.07
169P84	8.5x17"	$8.03	$7.23

TRS-80 apple II

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4116's RAMS
(16Kx1 300ns)
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add $5.00 for new Programming. Jumpers for TRS-80 may also be used for S.D. EXPANDORAM

2708

8K 450 ns
EPROM
FACTORY PRIME
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These low cost DIP sockets will accept both standard width plugs and chips.
For use with chips, the sockets offer a low profile height of only .125" above the board. These sockets are end stackable.

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WRAP POST
for .042 dia. holes
(all boards on this page)
T44/C pkg. 100 .. $ 2.34
T44/M pkg. 1000 ..... $14.35
A-13 hand installing tool .... $ 2.94

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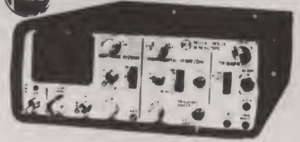

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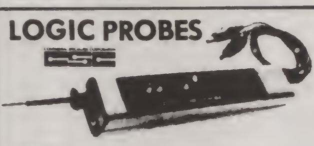
CSC



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Converts RS-232 to 20mA current loop, and 20mA current loop to RS-232
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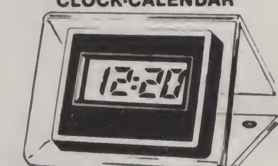

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Card Extender has 100 contacts, 50 per side on .125 centers. Attached connector is compatible with S-100 Bus Systems . . $25.00
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Same as 8800V except plain; less power buses & heat sink.

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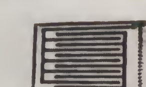

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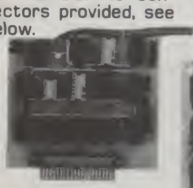

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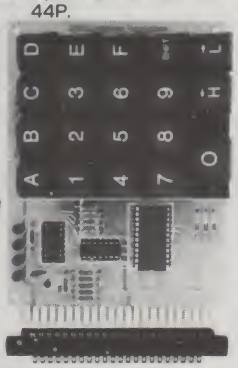
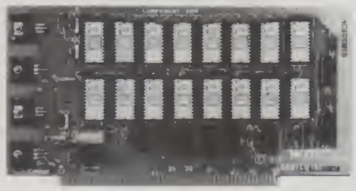


4K EPROM *wmc inc.*

This board is designed to operate with any speed or power 1702A. Addressable in 4K byte increments and can be configured to occupy either 2K or 4K segments. It can be populated one memory chip at a time. Bare board $30, board with parts $200, assembled $230. Part No. EPM-1



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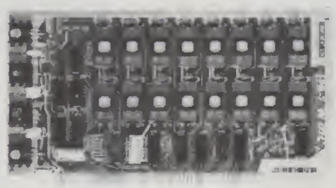

8080A CPU (With Eight Level Victor Interrupt Capability) *wmc inc.*

Uses the 8080A and the 8224 clock chip. The crystal frequency used is 18 MHz and the vector interrupt chip is the 8214. The board will function normally without the interrupt circuitry. When the interrupt circuitry is built up, the board will respond to eight levels of interrupts. Designed to be a plug-in replacement for the IMSAI CPU board and will work in other computers with the appropriate modifications made to the ribbon cable connector pin out from the front panel. The board will work in systems without a front panel if the system has a PROM board that simulates the functions of the front panel. Bare board $30, with parts $185, assembled $220. Part No. CPU-1

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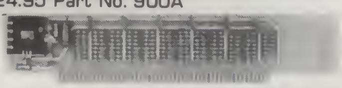
S-100 BUS ACTIVE TERMINATOR *

Board only $14.95 Part No. 900, with parts $24.95 Part No. 900A



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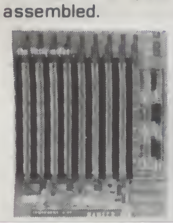

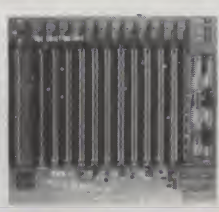

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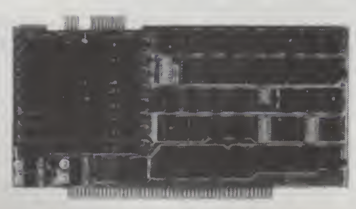

8K EPROM PIICEON

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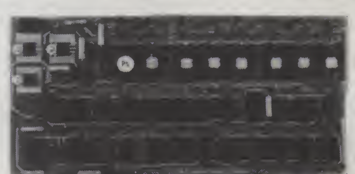

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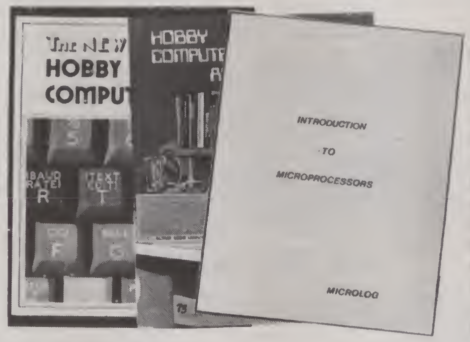

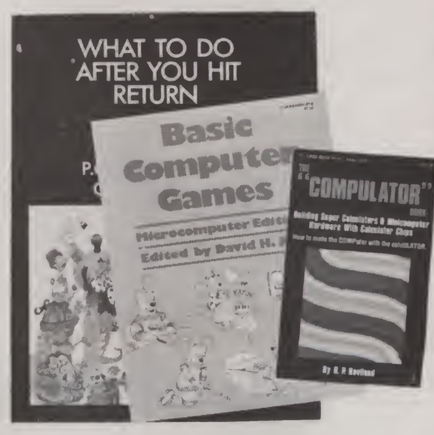

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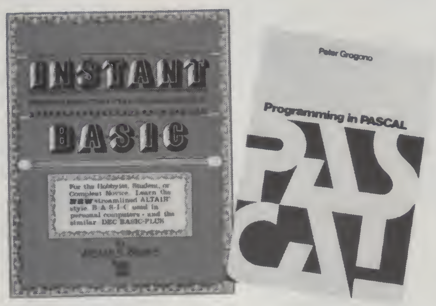

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